THE

ELECTRICAL REVIEW.

VOL. LVI. MAY 5, 1905. No. 1,432.

ELECTRICAL REVIEW.

Vol. LVI.] CONTENTS: May 5, 1905. [No. 1,432.

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THE

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STANDARDISATION OF FUSES.

IN our last issue we referred to the desirability of installing efficient fuses on tramcars, to supply the deficiencies inherent to the mechanical circuit-breaker. But it is not only in this direction that there is room for improvement in connection with the fusible cut-out and its applications.

It is a remarkable and not very creditable fact that although the fuse is one of the oldest, and apparently one of the simplest, devices employed by the electrical engineer, it still remains to all appearances in a state of chaos as regards carrying capacity, length of break and choice of material. Primitive in construction, unreliable and perverse in behaviour it remained, until the adoption of higher voltages for private supply compelled attention to its defects; since then, it is true, very substantial improvements in its design and construction have been effected, but the fact remains that at this moment there is no general agreement either as to the construction and rating of the fuse, or as to the proper mode of its testing and calibration.

That standardisation with respect to these matters would go far towards eliminating many of the sources of error which at present prevail, is clearly shown by the recent paper of Messrs. Schwartz and James, of which we gave an abstract in our last issue, and which teems with practical information, based upon extensive and accurate experimental investigations such as, we believe, have never previously been undertaken.

Having regard to the importance of the question to the industry at large, it is highly desirable that the matter should be officially taken up by the Institution of Electrical Engineers, or by the Engineering Standards Committee, and placed upon a proper and permanent footing.

How far the standardisation should be carried is a question calling for careful consideration of the requirements, which vary according to the type of service for which the fuses are intended; but undoubtedly by far the most pressing need is for the standardisation of fuses for use on distribution boards for electric lighting and similar purposes.

Excluding the various materials which we find in use in special circumstances—from hairpins and the wire round champagne corks or soda-water bottles to church door-keys—we find the following metals in common use:—Tin, lead, lead and tin alloys of various and varying composition, solid copper, stranded copper, tinned copper and zinc, in the form of wire or strip. Surely, of all these, there is some one which best fills the requirements of the case?

An examination of the fuse-holders now on the market for house installation work shows an almost endless variety of form and diversity of design. In some cases the wire is free in air from terminal to terminal; in others it is in contact for a portion of its length with the porcelain of the holder, either at the ends of the wire or at its centre, and this contact is usually of an indeterminate and variable character. Messrs. Schwartz and James have shown that the fusing current may be varied by as much as 50 per cent. by contacts of this sort. A similar diversity exists with regard to the length of break for a given carrying capacity and voltage, with a further liability to errors up to 30 per cent. This is a matter of grave importance, affecting as it does the reliability of the

fuse as a safeguard against fire, its most important function.

Non-interchangeability for both voltage and current-carrying capacity could be secured for a slightly increased cost, and the devices employed could easily be replaced as the necessity arose, by authorised persons.

With reference to the testing of fuses, a similar lack of recognised procedure is observable. They are usually subjected to a so-called short-circuit test, which, when carried out under different circumstances, may lead to results of the most divergent character, as was clearly shown in the paper above mentioned.

Tests for normal carrying capacity and normal fusing current are carried out but rarely, and then in divers manners, and with richly varied results. An appeal to a fuse table with a maximum + or − error of 20 per cent. is usually considered near enough for practical purposes.

By adopting some such procedure for the testing of fuses as that indicated by Messrs. Schwartz and James in their paper, many of the errors in the rating of fuse wires could be avoided, and their behaviour on true short circuit ascertained.

The general unreliability of fuses is due to an accumulation of errors; by eliminating these *seriatim*, there is no doubt that the fuse can be made an instrument of precision incomparably superior to the erratic and inscrutable device which, to our shame, it still remains.

The Development of Gas-Driven Central Stations.

In another column we print an abstract of a paper by E. M. Archibald, B.Sc., read before the Canadian Society of Civil Engineers, from which comparative figures as to cost of energy from steam and gas-driven generators, of a size suitable for many of our smaller central stations, can be deduced. These figures demonstrate the importance of running a gas-driven set at a high load factor. The steam-driven set is made up of two very flexible components—a dynamo which, in addition to carrying its normal full load at a good efficiency, is not debarred by sparking or heating limits from developing 25 per cent. or 30 per cent. overloads for short periods, and an engine which, while giving its best efficiency at normal rating, will respond with more or less steam-waste to extra demands. This quality of flexibility is imperative in ordinary central station practice. The overload limit of a gas engine is, however, much nearer to its point of maximum efficiency than in a steam engine; and therefore, in order to meet the calls for overload often made in practical running, it is necessary to install an engine of higher normal rating in the case of gas than in that of the steam set, and also to run it for a large part of its time at a lower load factor than in the case of the latter. This not only brings up the cost per kilowatt in actual running expenses, but causes the fixed charge to bulk more largely in the total cost. Gas-driven sets, therefore, are economical for steady, high load factors; steam-driven sets have their sphere where sudden calls for overload are made.

Another reason for keeping a producer gas plant fully loaded, lies in the fact that fixed charges preponderate in the total cost per unit for low load factors. This entails the reduction of initial outlay on plant to its lowest limit, and hence money spent on elaborate gas purifying apparatus considerably augments the cost per unit. But without good scrubbing arrangements, only the best anthracite coal can be used, in order to avoid the clogging action of carbonised tar in the engine cylinder. With a good load factor, capital may be laid out more freely in a completely equipped plant, as the effect of first cost in the price per unit is not so great, and in consequence a cheap bituminous coal may be used, the running expenses benefiting thereby.

The conclusion that an ordinarily variable lighting load is best met by a producer gas plant worked steadily at high load factor, in conjunction with a storage battery, is one borne out by several examples in Great Britain; a typical one was described in our issue of the 21st ult.

Radium in Celestial and Terrestrial Physics.

The discovery of radioactive substances bids fair to revolutionise our theories of the constitution of the sun and stars, and of some terrestrial phenomena, such as the rate of cooling of the earth. Prof. Snyder, in a paper read before the American Philosophical Society, alleges that he has discovered radium in the photosphere of the sun. The presence of radium in the sun has already been suggested by more than one physicist, and it has been shown that the sun's heat might be fully accounted for by a comparatively small quantity of radium per cubic metre. If the presence of radium in the sun and stars is once established, many of our old theories about these bodies may have to be modified. Prof. Snyder, for example, suggests that variable stars do not consist of one body revolving about another, but of single bodies, whose light is rendered variable by periodical outbursts of radioactivity. He concludes that the sun is a variable star with a period of 11 years, and that the sun spots are one of the demonstrations of the emanations of radium. Prof. Rutherford, in an article in a recent number of *Harper's Magazine*, applies the radium theories to terrestrial physics. The amount of internal heat lost per second from the earth by conduction to its surface can be readily calculated. Since 1 gramme of radium emits enough heat per hour to raise 100 grammes of water through 1° C., the present loss of heat from the earth is equivalent to that which would be supplied by the presence of 270,000,000 tons of radium. This quantity, though apparently large, if distributed uniformly throughout the earth's crust, would amount to only five parts in a hundred million per unit of mass. Calculations show that the radio-activity observed in soils corresponds to about this proportion of radium. It follows, therefore, that if radium is distributed uniformly throughout the whole earth's crust to the extent that tests indicate, the heat evolved by the radioactive material would compensate for the heat lost by the earth by conduction to its surface. This view upsets all the old calculations of the age of the earth, and would extend the time allowed for the evolution of living beings to an extent sufficient to satisfy the most exacting Darwinians.

Chemistry in Electrical Manufactures.

A few weeks ago, in some remarks upon economy in central station practice, we had occasion to refer to the importance of the study of chemistry in relation to electricity supply. In view of the progress with the commercial application of electricity to the processes of chemistry which have been made within recent years, it may seem superfluous to state that a sound knowledge of chemistry is of immense importance to the manufacturing electrician. Yet we are compelled to think that this is one of those axioms which, accepted in theory, are somewhat ignored in fact. For example, although the extensive manufacture of cables for electric light and power supply has been in progress for some 25 or 30 years, it was but four years ago that Mr. O'Gorman gave us the first paper directly dealing with the principles underlying their construction, and only quite recently that Messrs. Atkinson and Beaver warned us of the various ways in which cable insulations could be "doctored" for the market. That knowledge of this sort is not more general is due to the fact that it largely pertains to the sphere of the organic chemist, from whom the average electrician is poles asunder.

Col. Crompton, in his recent James Forrest lecture, furnished a fresh illustration of the importance of chemical knowledge in electrical manufactures. He pointed out that the reduction of copper cross-section in electrical windings, and therefore the size, and, to some extent, the cost of the machine, is limited by the temperature-rise permissible. This, again, is largely dependent on the degree of heat which an insulation will continuously stand without deterioration, and Col. Crompton ventures the hope that engineering chemists will shortly enable us to dispense with fibrous insulation for our coils, and to substitute a varnish or

enamel of good dielectric strength which will resist nitric acid and facilitate heat conduction. This will bring our heat limit up from, say, 100° C. to 200° C. Many cases arise where slight increase in copper resistance due to temperature rise is not of great effect as regards loss of efficiency, and, moreover, in the case of such windings the mean temperature rise is not very much larger, because a less depth and therefore larger proportion of cooling surface to mass may be presented. The intrinsic importance of such a development is obvious, and it is only a type of several problems which remain to be solved by electricians who specialise rather on chemistry than on mechanics.

Trade Unions and the Law.

Two cases of grave moment to trade unions were decided by the House of Lords on April 14th. As our readers are well aware, a change has taken place within recent years in the law relating to these bodies. In former times they were wont to think that in their every action they were beyond the reach of the law, that in the furtherance of a strike recourse might be had to violence and intimidation, to breaches of contract between employer and employed, without it being possible to fix the union as a body or the union officials with any responsibility whatsoever. All this has now changed; and one of the cases just decided by the House of Lords, namely, the Glamorgan Coal Co. and Others *v.* The South Wales Miners' Federation—better known as the Stop-day case—demonstrates the radical nature of the change. Though the history of this case is long and complex, the essential features of the dispute which led up to it may be recounted in a few words. In the year 1900 there was some feeling of dissatisfaction in South Wales with regard to the "sliding scale" of wages. The Federation, with a view to keeping up the price of coal, seems to have thought that if the output were diminished, the price of coal might be raised to the advantage alike of employers and employed. With this object a stop-day was ordered. The employers objected to this, and threatened proceedings if any further stop-days were ordered; but in spite of this the Federation ordered further stop-days at the end of 1901, with the result that a large number of pits were rendered idle, and a heavy pecuniary loss was inflicted upon the coal-owners. It is to be noted that for the men to cease work on a "stop-day" involved breaches of their contracts of employment. Now for the sequel. The employers joined together and brought an action, alleging that the defendants, well knowing the terms and conditions of the contracts of service under which the workmen employed at the collieries of the plaintiffs were working, wrongfully and maliciously, by causing notice to be given to the workmen employed at the plaintiffs' collieries, procured and induced the said workmen to break their contracts of service with the plaintiffs, and in breach thereof to abstain, without giving due notice, from working at the said collieries on certain days. The defendants alleged that they acted in the *bonâ fide* belief that the course of action advised by them would greatly benefit both the plaintiffs and the defendants, and that they had reasonable justification and excuse for the course pursued by them. After many vicissitudes, the case reached the House of Lords, where it was unanimously held that the plaintiffs were entitled to succeed. The interest of the case is centred in the line of defence. It was practically conceded that the Federation (as a Federation) had advised the men to break their contracts, but it was argued that it had just cause and excuse for doing so. What was the just cause or excuse? That, in the opinion of the Federation, the price of coal would be raised. It is noticeable, however, that the employers were not consulted upon this important point. Moreover, it could scarcely be argued that a trade union, by issuing an order to the members of the union to abstain from work on a particular day, merely gave those men advice. A few words from the judgement of Lord Lindley are of considerable weight. He said: "The so-called advice here was much more than counsel; it was accompanied by orders to stop, which could not be disobeyed with impunity. A refusal to stop work as ordered would have been disloyal to the Federation. This is plain from the speeches given in evidence at the trial, and, in my opinion, it is a very important element in the case, which cannot be ignored. As regards duty, the question arises—Duty to do what? The defendants have to justify a particular line of conduct, which is wrongful in aiding and abetting the men in doing what both the men and the officials knew was legally wrong. The constitution of the union may have rendered it the duty of the officials to advise the men what could be legally done to protect their own interests; but a legal duty to do what is illegal and known so to be is a contradiction in terms." The moral of the case is that it is no justification for inducing a workman to break his contract that, in the opinion of the union, the result of the breach will be good for master and man. *A fortiori*, it is no justification that the breach is likely to be beneficial to the workman only. We fancy that the trade unions have long since realised that the judgement of the House of Lords would be unfavourable; and that the prospect of an adverse ruling has done much to prevent them from having recourse to the violent methods which have done so much to give them a bad reputation in the past. It is hoped that now they are vested with a full sense of their responsibilities, they may be enabled to direct their counsels in more peaceful channels.

Fixation of Nitrogen.

Elsewhere in this issue we give a few particulars of an interesting process which has been devised for the fixation of nitrogen with the aid of peat, of which immense quantities exist in the Irish bogs. We understand that Mr. G. W. de Tunzelmann has had the process under investigation during the past three years, in collaboration with a chemical expert, and has satisfied himself that it is practicable from a technical point of view. Whether it will prove commercially successful, remains to be seen. The importance of the subject is beyond question, and will, we hope, justify our noticing this new system, although the process is a purely chemical one.

Apart from the valuable investigations which are being carried on at Niagara and in Sweden, with a view to the direct fixation of atmospheric nitrogen by electrical means, electrical engineers are interested in the production of nitrogenous fertilisers by way of the Mond process of gas production, which, in fact, is closely allied to the process now put forward. The connection is collateral, so to speak, for it is only as a by-product that the electrical engineer is concerned with sulphate of ammonia; but he hopes by its production to be enabled to supply electricity at lower rates than would otherwise be attainable.

Seeing that the development of a successful industry of this description in the sister isle would be of immense benefit to the Irish people, we cannot but hope that the expectations of its founders will be fully realised.

Unwelcome Flattery.—One of the most noteworthy features of the very gassy gas exhibition held last year was the strong tendency on the part of the gas world to imitate the appearance of electrical fittings. This, of course, was not surprising, except in that it so candidly revealed the admiration, not unmixed with envy, of gas men for electrical fittings, and constituted a most telling testimonial to the superiority of electric lighting.

But when—as in the case of the "'London' Arc Lamp," which is simply a gas fitting arranged for four incandescent gas mantles—the very *name* of the electric lamp is appropriated, our feelings of gratification derived from the flattery are mingled with annoyance at the impudence of the misnomer.

Fortunately, no one who sees these gas "arc" lamps is likely to mistake them for electric arc lamps; the only danger is that discredit may be brought upon the latter. Of one thing we may be sure—while gas men may imitate electric lamps and appropriate the names thereof, no electric lamp will ever be made to resemble a gas lamp, and above all, no electric arc will ever be called a gas lamp. The crow may dress himself in peacocks' feathers, but the compliment is not reciprocated.

D

CONSIDERATIONS RELATING TO THE DESIGN OF THE ARMATURE SLOT INSULATION IN HIGH VOLTAGE ALTERNATING CURRENT GENERATORS.

By H. M. HOBART.

(*Concluded from page* 681.)

Obviously we cannot directly apply natural mica to the purposes of slot insulations. But even could we do so there are grounds for suspecting that there may not be so wide a margin between the required specific strength as shown in Curve U, and the true disruptive strength of natural mica. These grounds are furnished by the researches of Dr. Walter,* who, by a so-called "Picein Drop" method of testing, has come to the conclusion that for a homogeneous material, the true disruptive strength is directly proportional to the thickness; in other words, the specific disruptive strength is a constant for a given quality of a given material. Some tests made by Dr. Walter on the strongest parts of specimens of various good qualities of natural mica, gave the results shown in Table II. :—

Table II.—Results of Dr. Walter's Tests of the Specific Disruptive Strength of Natural Mica

Source.	Thickness in mm.	Specific disruptive strength (R.M.S. volts per mm.).
German East Africa	0·45	28,000
	0·75	28,500
Calcutta...	0 48	17,500
Madras	0·35	24,500
Russia	0·48	21 000
Ceylon	0·50	20,000

It will, therefore, be safer to admit the possibility of the correctness of Dr. Walter's conclusions, and to take the specific disruptive strength of natural mica at 25,000 R.M.S. volts. As the specimens in Table II. varied in thickness from 0 35 mm. to 0·75 mm., we have in fig. 4 drawn the short horizontal line connecting these two values for an ordinate of 25,000 R.M.S. volts.

These considerations lead us to the curves and data set forth in fig. 5. It is evident that the ample margin

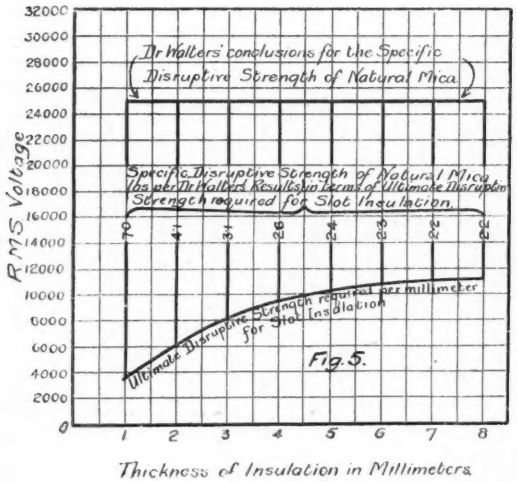


Fig. 5.

which at first appeared to exist between our requirements and the means at our disposal has rapidly decreased. What further allowance must we make? We must, first of all, obtain a *flexible* insulation. One of the available materials having this property may be described as "reconstructed mica." Small and very thin flakes of natural mica are stuck together by an insulating cement, and with the application of high pressures and temperatures. The product is sufficiently flexible for the purposes of slot insulation, and has been widely used. Under test it generally shows a disruptive strength well up towards 40,000 R.M.S. volts per millimetre, for thicknesses up to 0·5 millimetre or more, but falls off to 20,000 R.M.S. volts or less, for thicknesses of several millimetres. But without plotting such results we will proceed directly to the consideration of the curve in fig. 6, which is derived from data published by Arnold,* and shows the values of the dielectric stresses which, for various thicknesses of "reconstructed mica," suffice, if continuously applied, to set up a perceptible heating in the material. In fig. 6 we have also reproduced the Curve U, of fig. 4, and we see that our margin has now more than disappeared. It must not, however, be concluded

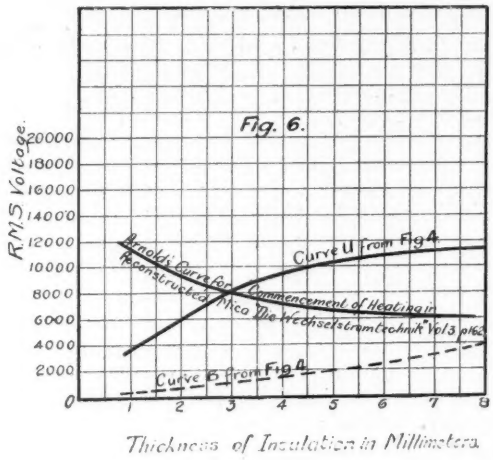


Fig. 6.
R.M.S Voltage
Arnold's Curve for Reconstructed Mica
Curve U from Fig 4
Commencement of Heating in Die Wechselstromtechnik Vol 3 p162
Curve B from Fig 4
Thickness of Insulation in Millimeters

Fig. 6.

that heating exists at *normal* voltage due to dielectric stress. This would not be the case for any reasonably liberal design, and to emphasise this point, the lowest Curve B, of fig. 4, which represented the dielectric stress at normal voltage of the machine, has been reproduced dotted in fig. 6. Evidently, however, there is not much margin, hence the importance of a knowledge of this property for all materials employed for high-voltage insulation.

Nor is heating due to dielectric stress *necessarily* not permissible during normal operation. Of course, it introduces an additional loss, and is objectionable from this standpoint. But so long as the ultimate temperature rise in the insulation due to this, and all the other losses in the machine, does not injure the insulation or exceed the guarantee, the presence of such a dielectric loss should not necessarily be grounds for condemning a design.

Hence it behoves us to inquire further into the extent of this heating due to dielectric stress. An analysis of some tests made to determine this point, leads to the following *very rough* average result :—

If, for a given thickness, a voltage v is just sufficient to produce perceptible heating, then there will be 0·5° C. rise for every 1·0 per cent. increase in voltage. This rule will probably give too low values of the temperature rise for considerable thicknesses, and too high values for thin insulations, but the experimental data available are as yet too meagre to justify attempting to set forth any exact formula. So soon as the necessary data are available for any given material, this rule should be superseded for that material by some rule better representing the truth.

Using the above rule, we obtain for "reconstructed mica" the three curves of fig. 7, showing, respectively, for any thickness, the voltage corresponding to the commencement of heating, to 20° C. rise and to 40° C. rise.

There is thus ample evidence that the design of high potential insulations is far from being a matter to be slighted. Nor have we enumerated by any means all of the more important considerations. Thus the tests, to which reference has been made, have all been carried out on flat samples. When "reconstructed mica" is bent, it is almost certainly considerably weaker at the bend than at the flat portions, and the inferiority should be some inverse function of the radius of curvature. Armature slots should, therefore, be

* "Ein Verfahren zur Bestimmung der elektrischen Durchschlagsfestigkeit boo isolierender Substanzen." B. Walter, *Elektrotechn. Zeitschr.*, Vol. XXIV., September 24th, 1903, p. 796.

* Arnold "Die Wechselstromtechnik." Vol. III. Berlin, Julius Springer, 1904.

designed with as large a radius of curvature at the corners as other considerations justify. Manufacturers of "reconstructed mica" provide non-flexible and flexible grades, and in the latter they are obliged to employ a greater amount, and a different composition of cementing varnish, in order to obtain the required flexibility. The presence of a cementing varnish of an unknown composition is in any case a source of concern, and duration tests as to the effect of exposure to moisture, to oil, to acid fumes, &c., become the more important. This suggests the question of substitutes for "reconstructed mica," and it may be said that there are two schools, one committed to the almost exclusive use of "reconstructed mica" for slot insulations, and another employing largely or exclusively impregnated fabrics. An important point affecting the question concerns the relative disruptive strengths of "reconstructed mica" and impregnated fabrics when employed to insulate conductors or groups of conductors of such forms as to require bending to various curvatures.

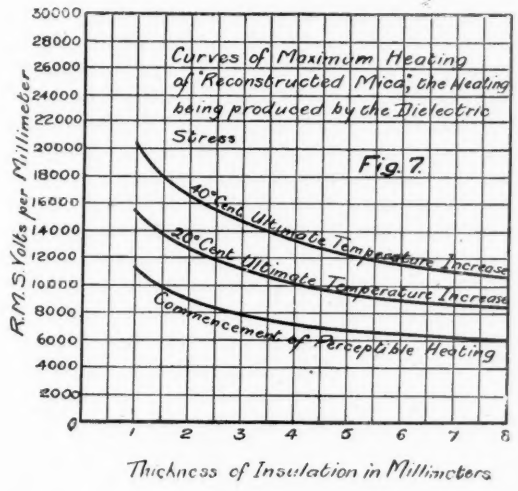

Curves of Maximum Heating of Reconstructed Mica, the Heating being produced by the Dielectric Stress
Fig. 7.
10°Cent. Ultimate Temperature Increase
20°Cent. Ultimate Temperature Increase
Commencement of Perceptible Heating
R.M.S. Volts per Millimeter
Thickness of Insulation in Millimeters

Fig. 7.

"Reconstructed mica" might, and probably does, have as high or higher specific disruptive strength when tested in flat sheets, than any other material which could be employed for slot insulation. It is doubtful whether any precise data are available which would permit of estimating the percentage inferiority when curved, as a function of the radius of curvature. For this purpose I would propose the following tests, to compare in this respect "reconstructed mica" with an insulation consisting of some impregnated fabric which we will assume to have, when tested in flat sheets of a given thickness, some 75 per cent. of the disruptive strength of "reconstructed mica." Let samples from these two materials be prepared by using them to insulate brass or iron cylinders of 40 mm., 20 mm., 10 mm, and 5 mm. external diameter, the total thickness of insulation being, for the first series of tests, say 1·0 mm. The smaller the diameter, the less would be the disruptive strength per millimetre, but the rate of decrease of the disruptive strength will probably be more rapid for mica than for impregnated paper or tape. I recently supervised some tests on a set of such samples, for which the outer diameter of the brass cylinder on which the insulation was arranged, was 22 mm. The insulation consisted of tape wound on with one-half lap and impregnated with a certain varnish, and baked after the completion of each layer of taping, until a thickness of 1·3 mm. was finally obtained. The preliminary tests showed an average disruptive strength of 22,000 R.M.S. volts, or 17,000 R.M.S. volts per millimetre. Other identical samples were subjected to a temperature of 96° C. for 200 hours, and were then found to have an average disruptive strength of 24,200 R.M.S. volts, or 18,600 R.M.S. volts per millimetre. The improvement was doubtless due to the drying resulting from the long baking.

Taking Baur's law for the disruptive voltage, namely, that it is proportional to the two-thirds power of the thickness, the R.M.S. volts per millimetre for samples of one millimetre thickness would, in the latter case, have been—

$$\frac{24,200}{1{\cdot}3^{\frac{2}{3}}} = \frac{24,200}{1{\cdot}19} = 20,000 \text{ volts.}$$

I have no data on composite mica under equivalent conditions, but I consider that its disruptive strength would not be appreciably higher than the above figure, and it should be pointed out that much sharper bends occur in practice in slot insulations.

The results for various radii of curvature should be plotted as indicated in fig. 8, relating respectively to the ultimate disruptive strength and to the determination of the voltage sufficient to occasion perceptible heating of the insulation. Obviously it would be necessary in the second test, and if not absolutely necessary, nevertheless also desirable in the first test, to bring the voltage up by small steps, remaining during a sufficient and fixed interval on each step. In the first test this interval should be at least one minute. In the second test it should be at least five minutes. The samples should be carefully dried prior to the test, in a vacuum oven maintained at a moderate temperature, say 75° Centigrade.

The above has not been written with any intention of depreciating the merits of composite mica insulations, but to call attention to the fact that other excellent materials are also available. The vestige of cement always remaining between the leaves of mica is generally of secret composition, as are also the varnishes used for impregnating

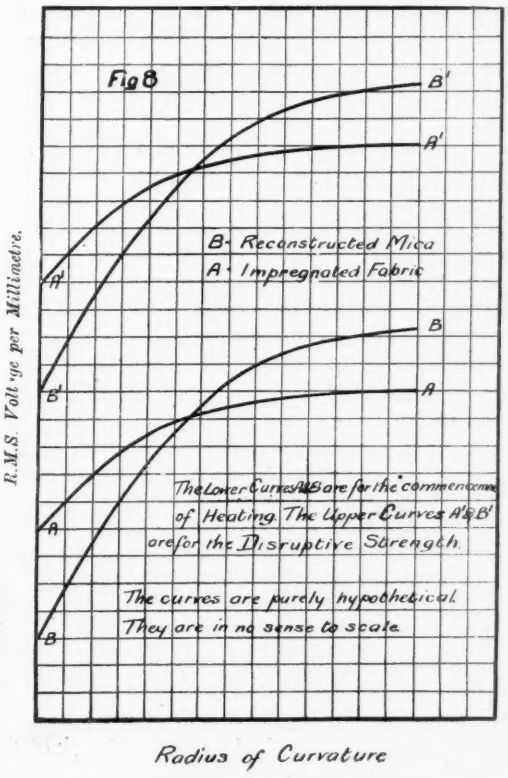


Fig 8
B' Reconstructed Mica
A' Impregnated Fabric
The Lower Curves A B are for the commencement of Heating. The Upper Curves A' B' are for the Disruptive Strength.
The curves are purely hypothetical. They are in no sense to scale.
R.M.S. Voltage per Millimetre.
Radius of Curvature

Fig. 8.

tapes, cloths and papers. These, undisturbed, would probably neither of them occasion trouble, but in the presence of moisture or other materials, such as the materials of the impregnated tapes, chemical processes may take place deleterious to the maintenance of the insulations.

Moisture, at least, can be more effectually guarded against than is at present customary. Vacuum drying ovens should be regarded as an indispensable accessory in a works where electric machinery is built. The cotton-covered wire and the other tapes and papers are received at the works often with from 5 to 10 per cent. by weight of moisture in the insulation, and this should be expelled in a vacuum oven immediately prior to winding, and again as often as possible at various stages of the manufacture, for, especially in a

climate such as England's, these insulations will be constantly ready to take up this percentage of moisture again. Hence the great importance of a recent suggestion from Mr. Highfield* that one should "fill in the whole of the space from copper to iron with insulating material, so as to entirely exclude air." This has, of course, often been proposed, but has rarely been reduced to practice, at any rate, not on a large scale. From the point of view of preserving the integrity of the insulation, the windings should be practically sealed up in a complete waterproof envelope; but this should only be done after every care has been taken to expel the internal moisture, otherwise the thermal objection to undue enclosing of the coils with insulation is alone experienced, and no gain from the insulating standpoint is obtained. In fact, unless the moisture is expelled in the first place, it is better to leave the insulating coverings open at the ends and to trust to the heat developed in service to periodically expel the moisture. The former plan of first expelling all moisture and finally giving the winding a complete waterproof covering is, however, the correct method for high tension machinery.

As to how far mica should play a part in such insulations should only be finally decided upon after far more exhaustive comparative tests than are at present available. These tests should comprise the subjection of numbers of sample tubes, such as I have described, to the prolonged influence of moisture, oil, and, as Mr. Highfield's experience teaches, to the prolonged influence of ozone, and of acid fumes. These "ageing" tests should be made under various temperature conditions, as well as under the influence of cyclic changes of temperature. The various varnishes on the market should be tested, and also the various grades of mica compositions. The combinations should be varied as regards the material of the tape or other wrapping, and great interest would attach to tests on samples consisting of a thin layer of mica midway between two layers of impregnated tape. It would be useless to draw final conclusions from other than most exhaustive tests, and although it is manufacturers who should primarily be chiefly interested, the carrying out of such tests generally devolves upon institutions for technical instruction, and there would appear to be no difficulty in the way of

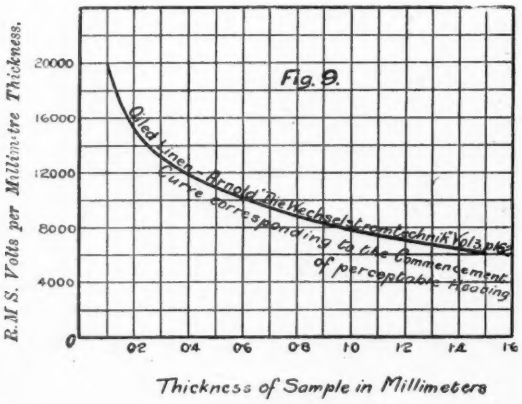


Fig. 9.

obtaining most valuable results from students' work on these lines. The amount of work requiring to be done is inexhaustible, but before concluding the article, it is well to again lay emphasis upon the feature of heating of the insulation due to the dielectric stress set up in it, either during the subjection to extra high voltages for testing purposes (and from this standpoint the duration of the test should be limited in cases where heating would ensue) or during normal operation. This point should be investigated for all materials. Some results for mica have already been shown in fig. 6. Arnold has given some similar data for "oiled linen" from which the curve in fig. 9 has been derived.

Arnold states that some firms quote the insulation strength of their materials in terms of the voltage for a given thickness, which will cause an ultimate temperature rise of 3° C. He states that for "reconstructed mica" this is from one-fourth to one-eighth of the disruptive voltage, whereas for "oiled linen" it is only half that voltage. It would appear, however, to the writer that Arnold over-estimates the disruptive strength of "reconstructed mica" and under-estimates the disruptive strength of impregnated fabrics, or possibly the "oiled linen" to which he refers was a poor representative of the latter class of insulation. To fix ideas, a number of mis-

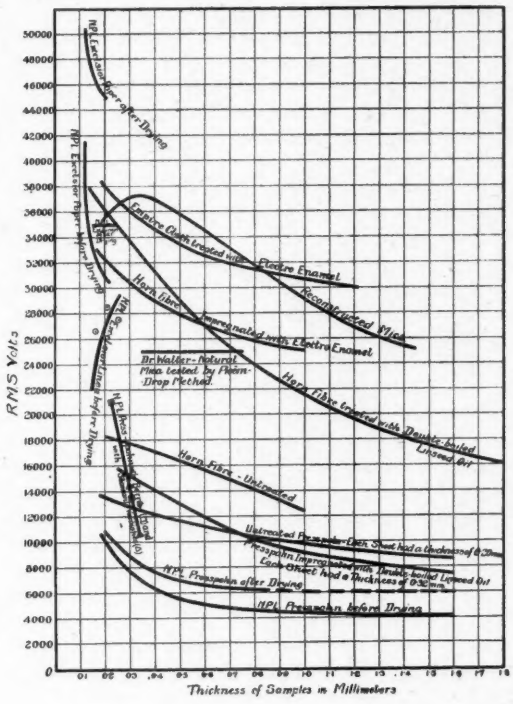


Fig. 10.

cellaneous tests, which the writer has collected from a number of sources of varying reliability, are brought together for reference in fig. 10. In none of these tests is sufficient information available regarding the conditions under which the tests were made. It is, however, interesting to note that an impregnated paper is amongst the best as regards disruptive strength, and this brings to mind the fact that paper, which is so extensively employed as insulation for cables, enjoys as yet comparatively restricted use in the construction of dynamo-electric machinery. This is largely on account of its comparative unsuitability for withstanding high temperatures. Nevertheless, it would be of interest to include various paper compositions in the list of materials which it would be desirable to investigate on the lines indicated in this article.

EFFECT OF LOAD FACTOR ON COST OF POWER.

It behoves every engineer who is concerned with the installation or extension of plant for electricity generation to study the influence of the load factor on the cost of power supplied. Figures given by Mr. E. M. Archibald, B.Sc., in a paper before the Canadian Society of Civil Engineers, though not applying directly to English practice, indicate the lines on which such problems should be attacked.

Analysing the cost of power into management expenses (these being practically constant with a given system and peak load, irrespective of load factor); distribution costs, subdivided into the invariable items of fixed charges and maintenance, and the variable items of losses in lines, meters, transformers, earths, and thefts (the last two being kept

* "The Insulation of Armature or other Coils for High Tension Apparatus." J. S. Highfield, *Electrician*, Vol. 54, January 27th, 1905, p. 573.

within fixed limits by dint of constant attention); and cost of production, the latter is dealt with in full.

The investigation is conducted by analysing the generation costs for the following specific cases :—

1. A plant of 750-KW. peak load, of three units of 300-KW. capacity each, and 25 per cent. overload capacity. No automatic stoker economisers or coal-handling apparatus are used. The cost of (*a*) condensing, (*b*) non-condensing, is considered independently.

2. For a peak load of 1,500 KW., three units each of 600-KW. capacity. Condensers and automatic stokers, but no economisers or coal-handling apparatus, are used.

3. A producer gas plant for a peak load of 750 KW., three units each of 300-KW. capacity, with 25 per cent. overload capacity on the generators. It is noted in passing that, as the overload rating of a gas engine is to that of a corresponding steam engine roughly as 15 to 50, a gas engine of 530 normal B.H.P. will be equivalent to a steam engine of 450 I.H.P. in reserve capacity. At normal load (300 KW.), therefore, the gas engine is 30 per cent. underloaded, with consequent poor efficiency.

The first cost of the complete plant is placed at $131.6 per KW. for (1*a*), $127.4 for (1*b*), $134.0 for (2), and $186.0 for (3). With interest at 5 per cent., taxes and insurance at 2 per cent., depreciation of machinery at 10 per cent., and depreciation of buildings at 3 per cent., the fixed charges amount to $17,121.75, $16,462.75, $36,318.75 and $26,080.5 per year for the respective plants. The above costs are for 100 per cent. load factor; due to decreased boiler capacity required on lower load factors (sufficient reserve against accidents, repairs and peak loads being provided), they may be reduced somewhat in the steam plants. For example, with 40 per cent. load factor —a usual figure—the fixed charges are reduced by about 6 per cent. by overloading the boilers at the peak. In gas plants the cost of storage for low load factors about equals that of an extra producer. On this modified basis fixed charge curves can be plotted in cents per KW.-hour for load factors from unity to 0·1 in each of the four cases.

The operating charges—labour, oil and waste, supplies, water, repairs and fuel, vary with the load factor; though below 40 per cent. load factor labour remains constant. Since the more hours per day the plant is run the more oil, waste, supplies, water and repairs are required, these vary practically directly with the load factor. The cost of coal per unit varies with some power of the load factor less than one, depending on the number and efficiency of engine and boiler house units of plant, the cost of coal per ton, its heat value, and the performance of the fireman. With fuel of calorific value of 12,000, 1 KW.-hour being generated from 3·5 lb. coal at 40 per cent. load factor on the steam plant, and in the gas plant 1·4 lb. coal developing a B.H.P.-hour at 50 per cent. load factor, the total generation costs are assessed in cents per KW.-hour as follows :—

LOAD FACTOR.

Plant.	100 per cent.		70 per cent.		40 per cent.		20 per cent.	
	A	B	A	B	A	B	A	B
1*a*... ...	0·84	0·93	1·01	1·16	1·45	1·61	2·49	2·7
1*b*... ...	0·90	1·08	1·09	1·29	1·53	1·76	2·6	2·86
2	0·68	0·82	0·81	0·94	1·14	1 29	1·92	2·1
3	0·76	0·82	1·00	1·10	1·6	1·7	2·86	3 0

A, refers to coal at $2 per ton. B, to coal at $3.

There is hence greater economy in the gas than in the steam plant for the sizes considered, at the higher load factors, but less at the lower, owing to the heavy fixed charges with the gas plant. Moreover, the higher the cost of coal, the greater is the economy of the gas over the steam plant at high load factors. A determination of the percentage ratio of individual items of generating expenses to the total cost shows that although at high load factors the cost of fuel preponderates over other expenses, at low load factors the fixed charges are the heaviest item; hence, when the load factor on a system is low, the fixed charges govern the cost of power, and capital outlay must be conservatively dealt with, particularly if coal is cheap. If the load factor is high, extra investment in apparatus, such as coal-handling plant, to reduce cost of labour and fuel, is permissible.

The costs of management and distribution are not fully dealt with in the paper, but their influence on the cost to the consumer is indicated by the example of Plant 2 above. Allowing that $50,000 per annum covers the fixed charges, maintenance and attendance on the distributing network, $35,000 the management expenses, profits and miscellaneous outlays, and distributing losses being taken as 30 per cent. of station output, tne cost to the consumer in cents per unit is 1·94 for 100 per cent., 2·5 for 70 per cent., 3·9 for 40 per cent., and 7·2 for 20 per cent. load factor. These may be compared with the generation costs above, and show the advantages that accrue to long-hour customers.

ELECTRICITY AS MOTIVE POWER FOR A 1,100-TON CARGO-BOAT.*

BY J. W. H. HAMILTON.

SEVERAL systems for the transportation of boats by means of electric power have been tried. For small launches, going short distances, the electric accumulator soon entered the field. For the towing of heavy canal boats the "electric mules," or locomotives, running on a track along the canal and taking the current from an overhead trolley wire, have been used in Europe for several years, and have also been tried in this country. The idea of carrying a complete electric generating plant on a ship, and using electric motors on the propeller shafts may be new to the engineers on this side of the Atlantic.

The high efficiency and small weight and bulk of modern oil engines has made them very desirable as prime-movers of ships. However, for many years their use has been limited to small motor boats, on account of the difficulty in making a good reversible and variable-speed oil engine. The various kinds of reverse gears, which are extensively used on small boats, are entirely impracticable on large ones, and it was, therefore, suggested to introduce electricity as transmitting power between the engines and the propeller shafts. Through this arrangement the simplest and most complete control of the boat is obtained. A cargo-boat built on this principle was completed last year, and has been in daily service for several months. The technical as well as the economical success of the system has already been proved, and a second boat of similar design has been ordered. A few data may be of interest to electrical engineers, and will probably make shipbuilders of the old stock ask themselves whether a revolution in the maritime transportation will not soon be at hand.

The boat, which is named *Vandal* was built for Nobel Brothers, of St. Petersburg, the big Russian company,

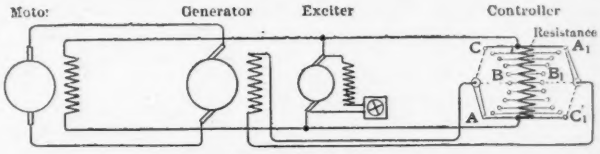


FIG. 1.—MOTOR-CONTROL CIRCUITS.

for the transportation of oil from Rebinsk on the Volga to St. Petersburg, a distance of 700 miles. The hull of the ship, which is made of steel, was built in Nischni Novgorod. The overall length is 245 ft., beam 32 ft., and at full load the draught is 6 ft., and the displacement about 1,100 tons. As the river in many places is very shallow, the bottom of the ship has been made flat. Three propellers are used, and three units of oil engines of the Diesel type, direct connected to the electric generators. The generating plant is located amidship, and the three motors are in the stern, thus reducing the propeller shafts to minimum length. Oil tanks for the engines are located in the bow and stern; their aggregate capacity is about 12,000 gallons. The amount of oil consumed on one round trip is about 3,600 gallons.

Each of the three Diesel motors develops normally 120 effective H.P. They are vertical, three-cylinder, single-acting, four-cycle engines, built by the Diesel Motor Co., of Stockholm, Sweden. These motors run almost as smoothly as

* New York *Electrical World and Engineer*.

steam engines, the combustion in the cylinders being rather slow. Another advantage of the Diesel motor is the self-ignition of the gases, caused by their high compression. All trouble with spark apparatus is thus eliminated. The Swedish Diesel motor has reached a very high grade of perfection. The complete combustion of the gases, combined with the practical arrangement of these motors, make them more efficient than any other engines in the market. Careful tests on large machines in actual service have shown that at full load 35 per cent. of the energy in the fuel is turned into useful work. Compared to the very best steam engines, for which the corresponding figure will be 13 per cent., the result is remarkable.

The three electric generators are connected by leather couplings to the Diesel motors. Direct-current machines

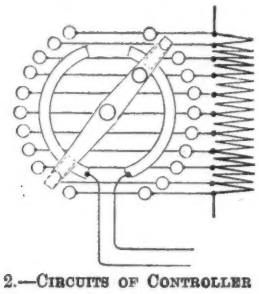


Fig. 2.—Circuits of Controller Arm.

are used. Each generator feeds it own motor, but can, if necessary, be connected to any one of the three propeller motors. The exciters are mounted on the generator shafts and supply current not only for the generator and motor fields, but also for the lighting of the ship, searchlights, steering gear, pumps, hoists, &c. Controllers for operating the propeller motors are mounted on the bridge, so that the man in charge of the ship can run it by turning the handles of the controllers. The whole electrical equipment has been furnished by the Allmänna Svenska Electriska Aktie-Bolaget, of Westeras, Sweden (The General Electric Co., of Sweden).

Some details of the controlling apparatus have been worked out very ingeniously and possess some novel features. The principle of the motor control is shown in the diagram (fig. 1, p. 719). As the exciter is used for various purposes, its voltage is held constant. A resistance is shunted across its brushes. This resistance, which has several taps, is connected to two sets of contact buttons on the controller. The generator field is connected to the two contact arms. Suppose that the motor is running and that the controller arms are in position, A A_1. The generator will then receive full field current. The motor always gets its field current directly from the exciter. By moving the contact arms towards B B_1, the generator voltage will drop, and when the arms come opposite to each other there will be no excitation, and the motor will stop. If the arms are turned towards C C_1, the field current of the generater will flow in opposite direction, thus reversing the armature current and therefore also the rotation of the motor. By being able to stop, start and reverse the motor by changing merely the field current of the generator, a safe and effective control of the motor is obtained. The speed can be varied between 30 and 300 r.p.m., and the commutation is sparkless at all speeds. The efficiency of this system decreases very little at low speeds, as the copper and iron losses in the generator are very small at low field excitation.

In mechanical construction the two controller arms are combined in one, as shown in fig. 2. The curved sectors are connected to the generator field, and the contact buttons are connected directly to the resistance.

Obviously, the life of this controller, as well as that of the rest of the motor and generator equipment, will be very long, and the cost of maintenance will be insignificant. There is no main current to break and make, no arcing contactors to replace, and there will be no severe stress put on the insulation. These controllers enable a man on the bridge to change the speed of the motors from full positive to full negative value in 12 seconds. The whole system gives entire satisfaction. On ordinary boats the failure of the engineer promptly to execute the orders, given through some kind of signal system from the bridge, sometimes causes serious accidents. This source of trouble is entirely eliminated by controlling the motors direct from the bridge, and not through a second person.

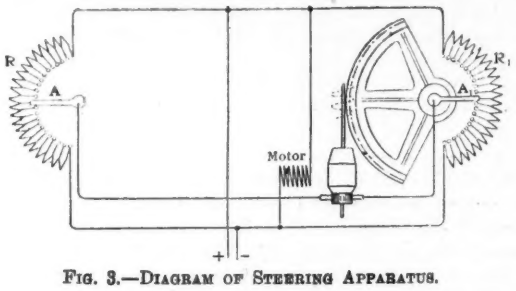


Fig. 3.—Diagram of Steering Apparatus.

The great amount of power required for steering a large ship necessitates the use of motors for operating the steering gear. Generally steam engines are used for this purpose, and they work satisfactorily. However, the whole mechanism is rather complicated and expensive, and requires a great deal of attention. Several kinds of electric steering apparatus have been tried successfully. The system adopted on the *Vandal* works very satisfactorily, and has the advantage of great simplicity. Fig. 3 shows a diagram of the arrangement. R is a resistance with a movable contact arm A, operated from the bridge of the boat; R_1 is a resistance with a contact arm A_1, connected directly to the rudder post. A shunt motor, the armature of which is connected to A and A_1, operates the rudder through a worm gear. The motor field coils and the two resistances, R and R_1, are connected in multiple to the exciter.

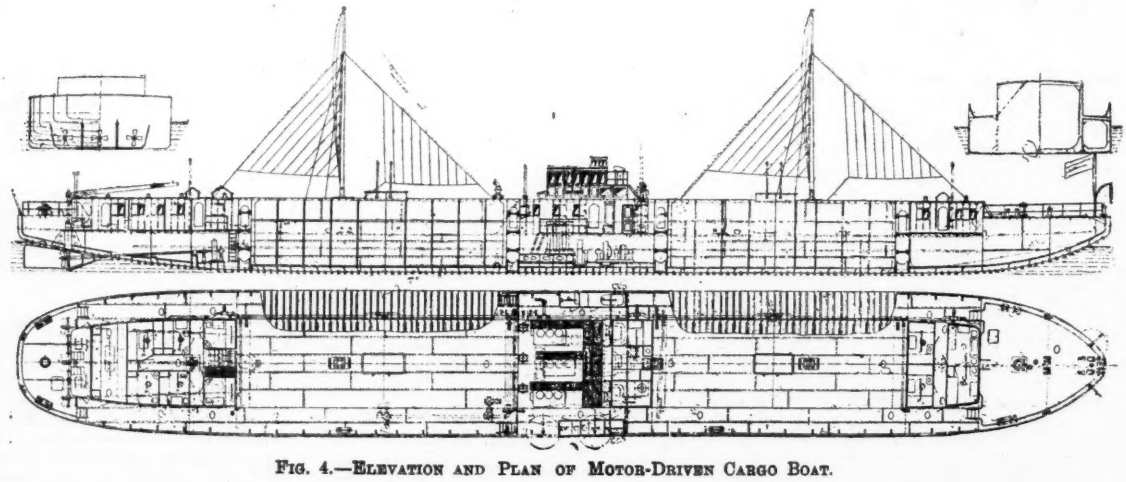


Fig. 4.—Elevation and Plan of Motor-Driven Cargo Boat.

As to the first cost of the machinery, the three Diesel motors and the whole electrical equipment, including also lighting, hoists, steering apparatus, pumps, &c., cost $30,000. Steam engine builders had offered to equip the boat with two compound steam engines of the same capacity as the three Diesel motors at a cost of $21,500. In order to make the electrical apparatus pay, a saving of somewhat over $1,000 per year must be effected. Experience has shown that, counting only the reduction in the fuel bill, this amount of money will be saved in two months, when the boat is kept running practically all the time. A few figures on the fuel economy will be of interest.

The thermal units of crude petroleum are about 11,000 CK. (calories per kilogram), and of coal about 8,000 CK. As has been previously stated, this type of Diesel motors will turn 35 per cent. of the 11,000 CK. of the oil into effective work, whereas a steam engine of the very best type will take care of only 13 per cent. of the 8,000 CK. of the coal. It is apparent, therefore, that 1 ton of oil will do just as much effective work as 3·7 tons of coal. The prices of oil and coal vary a great deal in different places. In St. Petersburg a ton of coal costs about $4.80. The price of petroleum averages $9 per ton. The coal will cost twice as much as the oil, and allowing 20 per cent. for the losses in the electrical machinery, the saving for fuel will be considerable. By reducing the weight of the fuel over 60 per cent., the carrying capacity of the ship will be correspondingly increased. Of course, the electrical machines will entail some extra dead-weight, but hardly as much as the water-filled boilers in a steamboat. Further, a great deal of piping and auxiliary machinery, necessary for a steamboat, is done away with. Everything considered, it was estimated that the cargo capacity of the *Vandal* gained 10 per cent. by using oil engines and electrical power transmission instead of steam engines.

The second boat, named *Samarat*, which is now being built, is of somewhat different design. Only two sets of Diesel motors are to be used, each developing 180 effective H.P. All machines will be located in the stern of the boat. No extra motor attendants will then be required. The engine and propeller shafts will be supplied with clutches, so that when the boat is to run a long distance without stopping, the engines will be connected directly to the propeller shafts. The first cost of the *Samarat* will be less than that of the *Vandal*, as only two sets of machines and one machine room will be used. The running expenses of this boat will also be reduced, as the electric transmission will be cut out for long runs and the number of dynamo tenders will be less.

Considering these facts, the *Samarat* will be a highly economical boat, and it will probably compare favourably with steamboats even in places where the price of oil is higher than in Russia. Obviously, the relative price of oil and of coal is the most dominant factor in deciding which type of boat will be the most economical for a certain locality.

FIXING ATMOSPHERIC NITROGEN.

SOME extremely important developments in electro-chemical industry have already been achieved in the course of the researches which have been carried on during the last few years with the aid of electrical power obtained from the Niagara Falls generating plant. This experimental work has been carried out, with characteristic American enterprise, on a very extensive scale, and at a very considerable expenditure of capital.

This expenditure has already been well repaid by the commercial results obtained both in improving existing industrial processes and in developing new ones, but of all these researches none has excited more general interest than the one which is still being actively prosecuted for the fixation of atmospheric nitrogen, in the form either of nitrates or of ammonia salts. Interesting results have been obtained, and the plant used has been described in our columns. So far, commercially practicable results do not appear to have been attained, but we believe the investigations are still being prosecuted energetically, in view of the great importance of the problem and of the immense financial reward attending a successful issue.

Fixed nitrogen is a necessity for the development of nearly every kind of vegetation, and wheat and other grain crops especially require it in large quantities. The rapid yearly increase in wheat cultivation is very largely responsible for the enormously increased demand for nitrogenous fertilisers such as guano, nitrate of soda and sulphate of ammonia.

The guano deposits are already practically exhausted, and the Chili saltpetre beds are rapidly approaching the same condition. The production of sulphate of ammonia is increasing from year to year, but its present principal source of supply, as a residual product in gas manufacture, is a limited one, as is shown by its steady increase in price.

The cheap production of nitrogenous compounds which can be assimilated by the roots of plants is, therefore, one of the most important problems of the immediate future, and the development of an electrical process which would afford a satisfactory solution would not only benefit those immediately concerned, but would give a most important impetus to the electrical industry generally by opening up an almost boundless field for the generation and utilisation of electrical energy.

While wishing all success to the seekers after such a process, the cheap production of nitrogenous fertilisers in quantity is a matter of such pressing importance that we are prepared to welcome any practical solution, even though it come from sources outside the limits of the industry with which we are most intimately connected, and therefore it is with pleasure that we learn that extensive works are being erected, and are nearly approaching completion, at Carnlough, in the north of Ireland, for the manufacture of sulphate of ammonia on an extensive scale.

The process, which is a purely chemical one, was invented by Prof. Wilhelm Eschweiler, of the Technical Hoch-Schule at Hanover, and Dr. H. C. Woltereck, of London and New York, and was taken up and developed by an English syndicate which was formed for the purpose nearly three years ago.

It consists essentially in passing a stream of air mixed with steam over a mass of peat in a state of slow combustion. The result of this is that some of the nitrogen contained in the air, and some of that contained in the peat, becomes fixed by means of hydrogen obtained by decomposition of the steam, forming ammonia, which is then taken up by sulphuric acid, and so converted into sulphate.

We are informed that over five tons of sulphate of ammonia are obtained from every 100 tons of peat treated, and that, on this basis, the cost of production is less than half the present market price of sulphate of ammonia.

The works, which are being erected at a cost of about £30,000, include an aerial ropeway a couple of miles in length, with a capacity of 60 tons an hour, for conveying the raw material from the peat-bog to the works.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Patent Agreements.

Mr. Raworth's letter and appeal to your readers might have been more effective if he had adopted Mr. W. S. Gilbert's "Pooh Bah" method of reasoning, viz.:—

"In my position as director, I am bound to support my colleagues in the generally accepted view of so and so, having regard to such and such possibilities."

"On the other hand, in my capacity as inventor, I bitterly resent the brain-sucking strategy of the management."

"Again, in my pose as political economist, I feel that my capacity as inventor should be duly recognised," &c.

Curiously enough, Mr. Raworth attempts to soothe the issues and explain his position by exactly the same expedient as "Pooh Bah," and "insults" his prebears, as far as his irrepressible gallantry will permit. But can Mr. Raworth reconcile his statement:—"The result of that agreement was paralysis," with the later paragraph, "Happily, for this country, &c., men go on thinking and working, &c.?"

Let us accept the latter; it is, perhaps, more emphatic. "I say this because I have seen it."

This puts the political economist right; the agreement makes no difference.

The inventor's position, as demonstrated by Mr. Raworth, is that he is forced by the agreement to earn thousands instead of hundreds; this appears to be satisfactory.

There remains the director's problem, apparently "something humorous but lingering—something with boiling oil in it—or melted lead." Can Mr. Raworth be persuaded to disclose the inner workings of the board?

Reader.

Tendering in Natal.

I enclose herewith an advertisement which appeared in a local paper on 15*th inst.*, and which will give you an idea of the style of thing one has to put up with in this country.

You will note that tenders are to be received before noon on 18*th inst.* It may also interest you to know that there is *one* firm in Natal which is agent for both Alley McLellan engines and Thomas Parker dynamos.

Further comment is unnecessary!

Onlooker.

Durban, Natal, *March* 21*st*, 1905.

GREYTOWN LOCAL BOARD.—ELECTRIC LIGHTING DEPARTMENT.

TENDERS are hereby invited for the supply of:—

One Alley McLellan simple acting non-condensing Steam Engine, coupled direct to Parker Shunt-wound Dynamo, 210 volts, 180 amps.

One Steam Separator, Tachometer, 4-in. valve.

Any other information to be had on application.
Tenders to be received on or before noon, March 18th.

A. ALLAN DUFF, *Town Clerk.*

A.C. v. D.C.

At the risk of meriting the accusation of irrelevance, I feel constrained to strongly protest against the offensive and personal tone of your later correspondents' communications.

For Mr. Abraham's information, I may authoritatively state that shift engineers, *taking any responsibility*, were never paid less than £100 per annum at Tunbridge Wells.

Until someone effectively replies to my letter of March 11th, I cannot say more on the matter.

W. Talboys Wheeler.

In Mr. A. J. Abraham's letter on the above subject, instead of keeping to the point, he makes some most uncalled-for remarks concerning the switchboard men at Worcester.

I can quite imagine, from the kind of letter he has written, that Mr. Abraham, when a switchboard man at Worcester, instead of attending to his duties, used to fill in his time at nap and fishing, but it is just as well for the community in general that the present switchboard men do not follow Mr. Abraham's example.

As Mr. Abraham's most unseemly remarks, if allowed to go unchallenged, are liable to interfere with the prospects of the Worcester assistants, I trust that you will be good enough to find space for this letter.

A. B. H. Cope,
Chief Assistant, Powick Works.

Worcester, *May* 1*st*, 1905.

I was rather surprised to find that "Shift Engineers"—so-called—allowed the remarks passed by the late chief assistant for Partick to go unchallenged. Anyhow, what Mr. Abraham says applies, I think, to the majority of stations.

The term "Shift Engineer" is a misnomer in a great number of cases. Before a man can call himself such, he ought essentially to be an engineer. By working in a number of stations, and visiting many more, I am inclined to think that the majority at the present time are not such, but are simply inflated switchboard attendants, pupils, &c., or what Mr. Kilburn Scott would term "pointer dodgers."

The majority of stations have a works superintendent and a foreman fitter, who stand before the "shift engineer," and have entire charge of the running of the station, or that part of it which affects the works costs sheet. The "Cult of the Marine Engineer" was an eye-opener to many station men. Mr. W. T. W. has got another one, but no more than he asked for, but he ought to think himself fortunate that he has been let down so easily.

Old Reader.

Tabloid Electricity.

I am much surprised that there have been no comments on "Greenhorn's" last letter.

I am very interested in the matter, it being an old, and I thought original, idea of mine.

Even if the scheme referred to by Mr. Broadbent were not a success 20 years ago, it scarcely follows that it might not be so now, always providing that the district were suitable.

In these days, when portable batteries to stand knocking about have been on the market for some time for the ignition system of petrol vehicles, the conditions of success would seem much more favourable. Hand and table lamps, &c., would need to be designed and the batteries made interchangeable.

Consumers could place a card in their windows, like Carter Paterson's, when they required a charged battery left, having been previously instructed how to detect a cell nearly exhausted. In the absence of any definite objections being given to the scheme, one is tempted to think it practicable, though revolutionary.

Pussy Cat.

The Dynamic Balancing of Rotating Machinery.

The recent tendency to considerable increase of the peripheral speeds of machines, consequent upon the introduction of turbine driving and the recognition of the economy in material effected by high speed design, has led to the necessity for greater care in the balancing of the rotating parts. It is well known that the static balance obtained by the knife-edge method of testing the balance usually employed is not necessarily a correct dynamic balance, and no static method can be satisfactory for very high speeds. In the United States, I understand that the problem of dynamic balancing has been solved by Prof. Elihu Thomson in connection with the Curtis turbines by the device of suspending the rotating part with its axis vertical by a rope, and balancing until it spins about its geometrical axis without vibration. I had not an opportunity of seeing this method in use, but it is unquestionably excellent in its results, as will be admitted by anyone who has seen these turbines running. It appears to me, however, that this method must be troublesome, in that it requires the suspension of the moving part, and that there is nothing to indicate in which direction the balance weight is to be fixed. Moreover, the free swinging round of large machines at high speed seems not unattended with danger.

A few weeks ago I was troubled with vibration in one of the motors in the laboratories of this Institute, which runs with a peripheral speed of about 4,500 ft. per minute, and it occurred to me to try a stroboscopic method of balancing. Instead of removing the armature from the motor, the whole machine in its normal state was mounted on a somewhat yielding support, so that at normal speed it ran with about $\frac{1}{32}$ in. amplitude of vibration both vertically and horizontally. The end of the motor shaft had a chalk mark made on one side of its centre. When the motor was running at full speed in the ordinary manner, the end of the shaft was illuminated by an arc lamp and lens, which threw a strong beam of light on it, and a disk about a foot in

diameter with a radial slot in it was interposed in the path of the beam. By rotating the disk with a small motor and regulating its speed, the chalk mark on the end of the large motor shaft could be clearly seen, and be made to appear to revolve slowly either forward or backward. When this was the case, the centre of the shaft could be seen to describe a small circle, and the direction of the radius of this circle was noted with respect to the chalk mark. On stopping the machine and attaching a balance weight in a position diametrically opposite to this direction, it was found possible in two or three trials practically entirely to eliminate the vibration.

In practice, this method might be very easily carried out by fixing the machine on a somewhat flexible timber baulk. There is no need for a darkened room if the light is somewhat shaded from the end of the shaft. Instead of employing an arc lamp, we may, of course, simply view the end of the shaft through the slit in the rotating disk, but the arc enables the want of balance to be observed by one or more mechanics with great convenience. The stroboscopic device is equally applicable to the method of suspension, and would render the balancing much more easy, but the writer believes that the method above described will be found sufficient for all practical purposes. For very perfect balancing, it would be advisable to illuminate both ends of the shaft in turn.

This device is, of course, an obvious one; but as I have not heard of its employment by anyone, I thought it might interest your readers.

Charles V. Drysdale.

Northampton Institute, London, E.C.,
April 27th, 1905.

Lightning Conductors a Source of Danger.

I am not sufficiently conversant with this matter to venture to give an opinion, but with reference to the fact of St. Mathias's Church, Richmond, being fitted with a conductor, and being badly struck by lightning, I would say that on the Sunday afternoon in question I was sitting in my dining-room, the window of which looks across the river on to Richmond from the Middlesex side. The thunder and lightning were heard and seen, I might say, simultaneously. My house shook from top to bottom, and I distinctly saw a fire ball, and mentioned this to those who were in the room. I furthermore said I was confident that a building in Richmond had been struck. On the following morning I heard from friends in the train that such was the case. There is no doubt that a fire ball, thunderbolt, or whatever it was, actually fell, as I clearly saw it descending from the clouds.

C. S. Northcote, M.I.E.E.

London, W.C., *May 1st*, 1905.

Electric Light and Calico Prints.

We should like to ask any of your readers if they can give us any information derived from their experience regarding the effect of electric lighting in distinguishing the colours of calico prints, both with reference to incandescent electric lamps, Nernst lamps, and arc lamps, and as to the relative advantages or disadvantages of the same, as compared with ordinary gas or incandescent gas light.

Calico Print.

Tramways Over the Bridges.

Although the close division on the question of permitting trams to cross the bridges of London, and the decision of the Speaker in respect to his casting vote, must have resulted in great disappointment in some quarters, it will probably be generally admitted that the public will gain by the retardation of a scheme which deals but partially with the grave problem of inter-communication between the North and South of the Metropolis. The first condition to improvement of traffic must be the widening of the bridges, or increasing their number, and, where possible, supplementing them by subways and railways. It is obviously faulty policy to add to the congestion of bridges already too small for their work. The problem is to transfer a given number of people over a comparatively short distance in the shortest possible time. The rate at which traffic can proceed across our existing bridges is determined by the speed and steering capabilities of the vehicles, and, just as the speed of a squadron is determined by the slowest vessel in its composition, so the average rate of traffic depends upon the clumsiest conveyances. So long as horse-drawn drays and donkey barrows, funerals and fire engines, pedestrians and motor-cars, traverse the same bridges, there will be haltings and processions, and the average rate of transit will remain sensibly constant. If to all these moving objects is added the tram, the clumsiest of all passenger street-craft, the result must be to reduce the average speed. Consider only the city *embouchure* of Blackfriars Bridge, admittedly one of the most dangerous traffic centres of the world; if trams were superposed upon such a whirligig of vehicles the result would be to stifle Farringdon Street, and if they did not block it they would certainly hinder the east and west traffic at that point. Waterloo and Westminster present similar difficulties. And, much as we appreciate the advantages of the motor-omnibus, this promising vehicle will scarcely improve the existing state of affairs, even supposing that it does not aggravate them. Literally, the matter requires dealing with on broader lines.

Pontifex.

[The Speaker gave his casting vote *against* the motion to shelve the question, so we fail to see that the scheme has been retarded in the present session. Theoretically, our correspondent is perfectly correct as regards the desirability of a new bridge for the tramways; practically, however the question of cost is a controlling factor, and we fear there is not much probability of the new bridge being built. Had the Council adopted the trolley system for its tramways, there would have been money enough to build the bridge, and one great hindrance to getting over the existing bridges (*i.e.*, the deep conduit) would have been non-existent. Our own view is that a physical connection between the northern and southern systems is absolutely indispensable, whether it be made over the existing bridges or over a new one; and it should not be forgotten that the tramcars will not be wholly additional to the existing traffic, but will themselves carry part of it.—Eds. E.R.]

Tests on Stirling Boilers at Neepsend Works.

It has always been my practice, when receiving anonymous letters, to consign them to the wastepaper basket unread.

If, therefore, "Calories" wishes to discuss the matter in question further, I shall be pleased to reply to his criticism, provided he will divulge his name, so that I may know with whom I am dealing.

S. E. Fedden.

Sheffield, *May 2nd*, 1905.

The Localisation of Faults on Cables.

May we at once state that we have as yet had no practical experience of the method of localisation referred to in the recent correspondence, but we hope shortly to give the method a trial. Perhaps Mr. Johnson will pardon us, however, for saying that we gave the matter serious thought before we wrote the letter to which he replies.

Mr. Johnson says:—"The testing is never carried out at the peak of the load." This looks rather like an indirect admission that the consumer's installation will, if the resistance be sufficiently low, materially affect the accuracy of the result.

Mr. Johnson also says:—"If there are a few lamps on . . . the resistance is high in comparison with that of the voltmeter." Now, the resistance of the voltmeter is not less than 25 ohms (*Electrical Magazine*), so that we can hardly accept the resistance of, say, a circuit of arcs in series, a small fan motor or a radiator as high in comparison with 25 ohms, and any one, or possibly all, of these appliances might conceivably be encountered. Four out of six tests mentioned in the *Electrical Magazine* were made between the hours of 10 a.m. and 3 p.m., and it is certain that if the supply were cut off a distributor in a busy district, the resistance between the conductors would be much below 25 ohms unless the consumers' switches were opened. Still, Mr. Bergh states most emphatically, and without any qualification, that this is quite unnecessary.

Mr. Johnson's information that "the test does not depend on the absolute value of the voltage drop" is as unnecessary

as his remark that "the shunting resistance remains practically constant between the readings of V_1 and V_2" is incorrect, as is easily seen if one gives the matter serious thought.

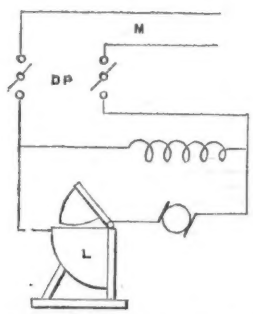
We have carefully worked out two cases, first without, secondly with a consumer's installation of 10 ohms resistance in circuit, and find the difference is appreciable, amounting to 12 yards in 500.

Of course, after all, the practical result is the criterion, and while we do not for one moment wish to disparage the utility of the test, still we venture to think that the very definite statements which have been made respecting the inability of consumers' installations to affect the result, require a little gentle qualification.

Weary Willie and Tired Tim.

Shunt-Wound Motor Connections.

I should like to have your, or some of your readers', opinions on the proper mode of connecting up ordinary shunt-wound motors to the mains. Do you consider the enclosed sketch of connections a good one, which might be put safely into the hands of a non-expert attendant, without fear that, by the operating of any of the switches shown, any damage may be caused to the windings of the armature



D P, Double-pole switch, with maximum current and no-voltage release; L, Liquid starter; M, Mains.

or field coils, when stopping or starting the motors, or by any induced voltage which may arise? In regard to this, I may say I have seen one or two gross mistakes made by firms from whom one is entitled to expect more knowledge, showing that the matter does not always receive the attention it certainly merits.

Safe Guard.

New Regulations for Electricity in Mines.

In reference to the new rules in connection with the Coal Mines Regulation Act of 1887, there are one or two points about which considerable doubt seems to exist. Clause 7 reads:—"In every completely insulated circuit earth or fault detectors shall be kept connected up in every generating and transforming station, to show immediately any defect in the insulation of the system. The readings of these instruments shall be recorded daily in a book kept at the generating or transforming station or switch-house."

There is no form of instrument at present on the market actuated by the pressure of the circuit in which it is working, which will indicate the insulation resistance of one main accurately; the readings always being affected by the insulation of the main not under test. Up to the present it has been customary to use a direct reading voltmeter of high resistance calibrated in ohms, one pole of which is connected to one main and the other pole to earth, with the object of determining the insulation resistance of the other main. This is always inaccurate, by virtue of the shunting action of the main not under test.

More than that, readings of the instrument may be utterly misleading, as, if the insulation resistance of both mains be approximately equal, a high insulation resistance will always be indicated, even if both mains are earthed.

The electrostatic ground detector is open to exactly the same objections, and, in fact, there appears to be no instrument on the market which will indicate at all accurately under the conditions specified.

All this is, of course, quite well-known, and in the light of this it is extremely difficult to understand what form of instrument the authorities who were responsible for the drawing up of the new rules had in their mind.

It would be interesting to inquire into the position of a colliery owner who, through inability to obtain a suitable instrument, is unable to comply with these regulations.

A. F. Harris.

London, E.C., *May 3rd*, 1905.

BUSINESS NOTES.

Automobile-Makers' Register.—The British Empire Motor Trades Alliance is compiling a register of British manufacturers of automobiles, motor engines, component parts and accessories. With the object of encouraging the home industry, it is intended to supply information to inquirers (private or trade) as to where any automobile, or requisite, manufactured in the United Kingdom may be obtained. British manufacturers are requested to send to the secretary, at 11, Red Lion Square, the fullest details of their manufactures, and to specify that they are manufactured in the United Kingdom.

Condensing Plant.—The Mirrlees Watson Co., Ltd., of Glasgow, has recently secured a number of important contracts, including the following:—

Lancashire Dynamo & Motor Co., for the Malta Dockyard. Four sets surface plant, each 7,000 lb. steam per hour.
Mr. P. J. Mitchell, London, for The Steel Co. of Scotland. Elevated jet plant, 45,500 lb. steam per hour, from two Rateau exhaust steam turbines.
J. G. White & Co., London, for Belfast Tramways. Three sets surface plant, each 24,500 lb. steam per hour.
North Metropolitan Electric Power Supply Co., Willesden Power Station. Surface plant, 16,000 lb. per hour. (Repeat order.)
Gloucester Corporation. Surface plant, 30,000 lb. steam per hour.

Tramway Guide.—An attractive souvenir has been prepared by the Metropolitan Electric Tramways, Ltd., for free distribution amongst the passengers on the new Edgware Road line, one of the most attractive "pleasure" routes out of London. The booklet contains 12 coloured views of places of interest on the way, together with a plan of the route, and a printed description of the scenes illustrated. A concise table of times, fares, stopping places, &c., appears on the cover. The Advertising Contractors and Printers, Ltd., of 5 and 6, Great Winchester Street, E.C., are responsible for this novel production, which will probably have numerous imitators as a means of stimulating pleasure traffic.

Acetylene Gas and Electric Smelting Co, Ltd.—Lords Justices Vaughan-Williams, Romer and Stirling on Tuesday heard an appeal from a decision of Mr. Justice Buckley dismissing a petition for the winding up of this company, on the ground that the petitioner's debt was too small. The company, whose registered offices are in Basinghall Street, Leeds, was incorporated in 1900 with a nominal capital of £25,000. It had works at Strangford, in Norway, and manufactured carbide of calcium and materials for the manufacture of acetylene gas. The petitioner had been the Manchester agent of the company, and had obtained judgement for £18 for services rendered as agent and issued execution, but there was nothing on which to levy a distraint. The company had made no answer to any communication from the petitioner, and had ignored the present proceedings. Their Lordships allowed the appeal to stand over for a month, petitioner in the meanwhile to communicate with the company at Strangford.

Vitrified Clay Conduits.—Messrs. J. F. Cummings and Co. announce that in future they will keep in London large stocks of these conduits ready for immediate delivery, ranging from single duct up to six-way, and that they are prepared to contract for complete installations in any part of Europe. They have at present in hand the complete city subway for St. Petersburg, which will take three years to lay down, and are supplying all the conduit for the telephone system of the Belgian Government. The conduit is also being used in London by the Charing Cross Electric Supply Co.

Fire.—In regard to their recent fire, to which we referred in our last issue, the Morley Electrical Engineering Co., Ltd., of Stanningley, notify that though their offices were practically destroyed, they hope to have their workshops going in a few days, and are arranging temporary offices on the premises in the meantime. Their business friends are asked to send copies of invoices, &c., and also price lists together with best trade terms and discounts.

Building Trades Exhibition.—An excellent exhibition of materials, manufactures, and appliances used in connection with the building trades, is now being held at the Royal Agricultural Hall. It was opened on April 27th by Lord Windsor, and will close to-morrow, May 6th. There is much of interest to be seen, and the exhibition is well worth a visit. Almost every branch of the trade is represented in the exhibits.

Reading Electrical Exhibition.—The exhibition of electrical machinery, accessories and appliances, held last week in the Exhibition Buildings, Vastern Road, under the auspices of the Reading Electric Supply Co., Ltd., was an excellent one, and proved quite a popular attraction. There were a large number of exhibitors. The company hired one of Messrs. Edmundson's travelling exhibitions, and this was supplemented by about 30 other well-known firms, among which were the following:—Messrs. J. S. Henry, Ltd.; The Saunders Launch Building Co, Ltd.; Vernon Davenport & Co., Ltd.; The Industrial Battery Syndicate; Harpers Automatic Co.; The Simplex Conduit Co.; Waygoods, Ltd.; The Reason Manufacturing Co.; Broom & Wade; The Windsor Electric Co.; The Isometric Lens Co.; Botley & Lewis; S. Griffith; W. H. Baughan & Co.; Veritys, Ltd.; The Singer Manufacturing Co.; A. E. Felgate; Hawkes & Sons. The company's generating station, which was also open to the visitors, formed an annexe to the exhibition proper.

Mr. S. Griffith, of Railway, Foundry and Engineering Works, Reading, exhibited the manufactures of his electrical department, managed by Messrs. Griffith & Biliotti, of 8, John Street, Adelphi, W.C. In addition to various D.C. motors and starters ranging from 2½ to 25 H.P., this firm displayed a line of polyphase motors. A noticeable feature of these machines is that, contrary to the usual practice, they are tunnel wound, and both stator and rotor are machined, this design making a very compact machine and ensuring a high starting torque with small currents. A further feature is that the slip rings of the W.B. type are inside the bearing, thus affording complete protection to the revolving parts. Amongst the novelties that were shown by him was a small drilling machine in which the drilling table is so arranged that it can readily be set at any angle or height, also an electric clock for use in works which automatically rings during the day at the starting and stopping hours. Messrs. Griffith & Biliotti's patent thermal cut-outs attracted attention; three types were shown, set to work with different time limits. One of them adjusted for use in central stations was acting within 1½ minutes with 50 per cent. overload and within 30 seconds with 100 per cent. overload, while for motor circuits two types were shown at work, one acting in 7½ minutes and the other in half-an-hour with 50 per cent. overload, thus answering to any specification to which motors may be designed. Switches, switchboards, and Messrs. Johnson & Phillips's cables and instruments, for which they are sole agents for the district, were also on view.

The Elieson patent accumulator, which was exhibited by the Industrial Storage Battery Syndicate, Ltd., of Reading, is worth mention. This accumulator was shown in the various stages of manufacture, and is intended for use in car driving. It can be rapidly charged and discharged without injury, and claim is laid to a touring car run of 75 miles on one charge.

Mercury vapour lamps of the "Bastian" type were exhibited, and Röntgen ray and Finsen light apparatus, together with a large variety of fittings, motors, lamps, fans, heating and cooking apparatus, &c., were also displayed. The application of electricity to power purposes was amply demonstrated. The exhibition closed on Saturday last.

Belgium.—A new company has just been formed at Liège, to be known as La Société de l'Auto Mixte, to develop the patents of M. Henri Pieper in connection with a new combination petrol-electric motor-car. The Société Internationale de l'Electricité, and the Société des Accumulateurs Tudor are interested in the new undertaking.

Flame Carbons.—Messrs. Schiff & Co. are introducing a new type of flame arc lamp carbons, designed to avoid the defects of the ordinary types. Metal rods are inserted in the centre of these carbons, and are in metallic connection with the metallic coating of the carbons; the points of the carbons are also provided with a metallic coating. It is claimed that the arc is steadier, and the voltage drop less with these carbons than with previous types. Messrs. H. G. Mayer & Co., of 67, Aldersgate Street, E.C., are the sole agents.

Catalogues and Lists.—CAMBRIDGE SCIENTIFIC INSTRUMENT CO., LTD., Carlyle Road, Cambridge.—New list of the Féry radiation pyrometers. Descriptions and illustrations of the mirror and lens pyrometers, Meylan-D'Arsonval galvanometers, and reflecting D'Arsonval galvanometers are included, also some notes on the applications of the apparatus and instructions for their use. Prices are given.

UNION ELECTRIC CO., LTD., London.—New descriptive pamphlet and price list of the "Excello" arc lamps. Full particulars of the construction, use, erection, trimming and candle-power of these lamps, which have lately demonstrated their capabilities for outside lighting, are published. They are specially intended for street, railway station, workshop, dock and similar lighting. The "Excello" carbons are also particularised in some detail. Prices appear of lamps, carbons, and sundry arc lamp apparatus. A list of streets, premises and yards in London and the provinces where the lamps are in regular use is given at the end of the pamphlet.

MESSRS. DICK, KERR & CO., LTD., Abchurch Yard, E.C.—Circular No. 107, giving numerous illustrations of wagons and rolling stock for portable and light railways, such as they have supplied for mining, factory, quarry, military and many other purposes in various parts of the world. Side and end tipping, also all-round tipping wagons, locomotives for light railways, haulage gear, mono-rail cars, standard types of axle-boxes and pedestals, are among the special lines shown.

MESSRS. JOHN KNIGHT & SONS, 24, Gertrude Street, King's Road, Chelsea.—List giving designs and particulars of their "patent reliable" sealed covers (with non-detachable gun-metal fastenings) for electric light and telephone inspection chambers in public footways, &c., for prevention of condensation inside cover, and reducing the danger and annoyance caused by surface water entering the chamber.

SIMPLEX STEEL CONDUIT CO., LTD.—Leaflet particularising their new bending machine for "Simplex" conduit. The bender, which weighs only 5 lb., consists of a wooden lever, a hinge link and a cast bending mould, which has two curved grooves of different radii. These grooves, together with the corresponding grooves in the end of the lever, take conduits up to ¾ in. diameter. The method of procedure is described in the leaflet. The device is claimed to be simple, portable and cheap.

MESSRS. FULLER, MACLEOD & CO., LTD., Norfolk House, Laurence Pountney Hill, E.C. Circular describing and giving the prices of the "Fulmac" coil for motor-car and motor-cycle use.

MESSRS. CECIL HODGES & CO, Balfour House, E.C. No. 3 picture-postcard illustrating their central station type of moving-coil instruments. The firm has been engaged in the instrument-making business for more than 15 years, and to-day the works are also very busy with general switchboard work. Among other switchboard contracts is that for the King's Sanitorium in Sussex.

MESSRS. W. & T. AVERY, LTD., Birmingham. Illustrated leaflet describing Avery's patent impact testing machine.

Forward Engineering Co. v. Banbridge Foundry Co.—In the King's Bench Court, Dublin, on 26th ult., this action was concluded. It was originally brought by plaintiffs to recover £143, price of goods sold and delivered, including £135, the price of an engine. The defendants paid into Court £138 on account of the original action, and counterclaimed for £500 damage for breach of contract in the sale of an engine. The defendants had been engaged to erect machinery and plant for the supply of electric light to Mourne Park, the residence of the Earl of Kilmorey. They ordered an engine from the Forward Engineering Co., which turned out unsatisfactory. The allegation was that it was not in accordance with the defendants' specification. The engine was replaced by another, but that also proved unsuitable and, as alleged, incapable of supplying the generating power required. For that alleged failure the defendant company counterclaimed for £500. The jury assessed the damages at £300.—Mr. Justice Madden asked the jury to say how much of the £300 they attributed to loss proved to have been occasioned by delay, and how much they awarded for the difference between the contract price and the value of the machine.—The jury, having considered these two questions, found that £76 6s. 7d. should be awarded for delay and £128 for the value of the machine, and judgement was given accordingly.

Book Notices.—"Fire Tests with Automatic Fire Alarm Systems." The System of the Autopyrophone Co., Ltd., Copenhagen. Red Book, No. 94. London: The British Fire Prevention Committee. 2s. 6d.

"Municipal Trading." An address delivered by Mr. Sydney Morse, before the Battersea Municipal Alliance. Westminster, S.W.: The Industrial Freedom League. 2d.

"The Engineering Press Monthly Index Review." February, 1905. Vol. V., No. 5. London: The Technical Press Association. 2s.

"Twenty-six Graduated Exercises in Graphic Statics, with an Essay." By T. Alexander and A. W. Thomson. London: Macmillan & Co., Ltd. 10s.

Liquidation.—A meeting of the Southern Electrical Installation and Wiring Co. will be held at Hastings on June 1st, to hear an account of the winding up from the liquidator (Mr. W. J. Larcombe).

For Sale.—On Friday, May 12th, Messrs. P. Huddleston and Co. will sell the stock and plant of an electrical engineer at Salford. On May 25th Messrs. Wheatley Kirk, Price & Co. will sell by auction 200,000 incandescent electric lamps, in connection with the liquidation of the Sir Hiram Maxim Electrical and Engineering Co., Ltd. Some particulars appear among our advertisements to-day.

Bankruptcy Proceedings.—May 13th is the last day for proofs for intended dividend in the case of Wm. Watson and G. Huntington, electricians, of Battersea Rise and Bond Street, London. Trustee, Mr. F. S. Salaman, 1, Oxford Court, Cannon Street, E.C.

A receiving order was made on April 27th on a creditor's petition against Harry John Salter, electrical engineer, 235, High Holborn, W.C.

An application for an order of discharge was made to Mr. Registrar Giffard at the London Bankruptcy Court on Wednesday, on behalf of Walter Charles Barsey, Dacre House, Arundel Street, Strand, and late of 34, Queen Street, Cheapside. Mr. Bowyer, Assistant Receiver, reported that the applicant failed in November 1904, with provable debts £3,363 1s. 9d., and assets which had only realised £2 7s. 2d. He had been engaged since 1895 in assisting in the promotion of, and acting as manager and director of, electrical cab, motor-car and other companies, most of which had been wound up. The failure was attributed to losses in connection with the various promotions, also to loss of about £850 on the sale in 1900 of an electrical engineering business with stock, plant and machinery, which had been commenced by him at Willesden. He sold the business for £4,000 in shares of a company formed to acquire it, but at the end of 1901 the debenture-holders of the company took possession, and in February, 1902, an order for the compulsory winding up of the company was made, the shares being valueless. Many of the bankrupt's undertakings, including those in connection with which the said losses

were made, were of a highly speculative character, and he had been to a great extent dependent on borrowed money. As offences, the Official Receiver reported:—(1) Insufficiency of assets to pay 10s. in the £ to the unsecured creditors; (2) Imperfect book-keeping; and (3) bringing on the bankruptcy by rash and hazardous speculations. After hearing Mr. John Langford for the bankrupt in support of the application, his Honour upheld the report, and imposed a further suspension of four years. Order entered accordingly.

LIGHTING AND POWER NOTES.

Bradford-on-Avon.—The R.D.C. has received from Messrs. Edwards & Armstrong, of Bristol, a communication asking for permission to run cables over or across the streets at Winsley and Turley for electric lighting. Winsley Parish Council supports the scheme, and recommended the R.D.C. to approve of it, and the Council has adopted this course.

Bolton.—The year's income from electricity has aggregated £47,452, which is a decrease of £228 compared with last year. There is also a decrease of £8,837 in the gas receipts.

Buenos Ayres.—From the report for 1904 of the German Transmarine Electricity Co., of Berlin, it appears that, in addition to the extension of the existing central electric lighting stations in Buenos Ayres, the company acquired during the year the station already leased to it, which was originally built for the Anglo-Argentine Tramways Co., Ltd. The purchasing company paid £350,000 in cash for the entire installation, and at the same time entered into an agreement with the tramway company, for the supply of all the electrical energy required for the working of the lines.

Chester.—In March last Mr. S. E. Britton, the Corporation electrical engineer, reported to the Lighting Committee on the development of the electricity undertaking, and after consideration the Committee recommended to the T.C. that:—

1. The present charge of 4½d. per unit, with discounts, for energy for lighting be reduced to 4d. per unit; the discounts remaining the same.
2. For all classes of meters a fixed charge of 1s. per quarter for each meter be made; these charges to come into effect from June 30th next.
3. Under the powers conferred by the Corporation's Act of 1901, that it provide and sell to consumers and contractors incandescent and Nernst lamps.
4. To advertise and circularise the uses to which electricity can be put.
5. The electrical engineer to prepare and issue a model specification and schedule dealing with wiring work, stating the quality of the materials and the way in which the work should be executed.
6. The Committee be authorised to rent a room in a central position in the city, wherein to exhibit and demonstrate electrical appliances, such as fittings, lamps, motors, heating and cooking apparatus, to be lent by the manufacturers of these appliances.
7. An exhibition of all kinds of electrical appliances be held at the Town Hall, for about 10 days in September next.

The T.C. on the 26th inst. adopted the report, with the exception of No. 6.

Continental Notes.—ITALY.—A concession has been granted to Messrs. Conti & Co., of Milan, by the prefectural authorities of Novaro, to erect a water-power plant on the River Ticino at Trecate, to supply electrical energy for lighting and power purposes.

BALEARIC ISLANDS.—A central electric lighting station has lately been completed near Inca, for the electric lighting of that town and a number of small villages in the district. Water-power is utilised.

Derby.—The T.C. has decided to substitute electric arc lamps for incandescent lamps in King Street, Queen Street and Duffield Road, at a capital cost of £360.

Dublin.—The Lighting Committee is considering its agreement with Mr. R. Hammond, which it desires to amend, so that the Corporation may avail itself of his offer to complete all the existing works in his original scheme. It could then justify before the Local Government auditor at a later date, the various sums of money paid to the contractors upon his certificates, and, at the same time, leave the Council free to carry out the extensions referred to in a previous report of the Committee, during the coming summer, without being obliged to pay 5 per cent. commission fees to Mr. Hammond, which, as the agreement of 1899 stands, the Corporation would be compelled to do.

Eastbourne.—In view of the increasing demand for energy, the Corporation has decided to lay down two additional mains from the works to a feeding point about 1½ miles away, where the cables for the supply of the various parts of the town separate. In consideration, however, of the summer influx of visitors, it has been decided not to commence this work until the close of September next.

Edinburgh.—The estimates of the electricity department for the year from May 15th, 1905, have been presented. £53,890 is put down for expenditure for the coming year, against an actual expenditure in 1903-4 of £43,130. The revenue on account of this expenditure is estimated at £128,705, against an actual revenue last year of £116,179. The Committee estimates its capital expenditure for the same period at £48,820. The Committee resolved to recommend that the charge for private lighting should be 3½d. per unit, for motor power, 1½d. per unit, for the present arc lamps, £10 15s., and for new lamps, £10 per annum, and it was also agreed to recommend that a charge of 1·10d. per unit be made to consumers not using motors during the heaviest lighting load in the four winter months, these proposals to take effect as from May 15th next.

Exeter.—It has now been decided that the proposed electrical exhibition shall be held in the autumn, not in June next, as stated in our last issue, and that in the meantime the committee bring up a report as to the probable cost.

Gloucester.—The T.C. has applied to the L.G.B. for a loan of £15,000 for extensions at the electricity works.

Gravesend and Northfleet.—The B. of T. has issued a draft order for the extension of Gravesend Corporation's E.L. area to the parish of Northfleet.

Greenock.—It was decided some time ago to adopt a scheme of free wiring to attract customers for electricity, but there are now so many applicants, that the Committee can select whom it thinks most desirable. During the last three months more lamps have been connected than in the past year. The demand is so great that new generating machinery has been found necessary for the electricity works at a cost of £2,900 as well as a storage battery. Authority has been given for the purchase of the new machinery.

London.—CITY.—The City of London Electric Lighting Co., Ltd., has decided that the rate for the supply of electrical energy, to all the public buildings of the Corporation, shall be reduced to 2½d. net per B. of T. unit from April 1st, to March 31st, 1906.

The Corporation Streets Committee has recommended that the present electric lighting of Fleet Street, Queen Victoria Street, and that portion of Lower Thames Street from Fish Street Hill to Billingsgate Market and Monument Street, be superseded by incandescent gas. The Committee urge that there will be a yearly saving of £363.

SHOREDITCH.—On Tuesday, the B.C. resolved to support the Supply of Electricity Bill.

ST. PANCRAS.—Further mains extensions at a cost of £1,750 are recommended by the B.C. Lighting Committee. Notice is to be given of a change in pressure of supply from 110 to 220 volts in the following districts:—Cumberland Terrace, Chester Place, Gate, and Terrace, Cambridge Terrace and Gate, and Albany Street.

HACKNEY.—The E.L. Committee of the B.C. has provisionally accepted a proposal submitted by Mr. C. Cotching, of Walthamstow, to lease for 21 years at £40 per annum, a portion of the land, now used as a clinker yard at the electricity and dust destructor works, for the purpose of erecting buildings and plant for the manufacture of bricks, &c., from the clinker. The terms and conditions of the lease provide that the lessee will accept delivery of all clinker, fine ash, and flue dust at any time during the day and night, and will pay the sum of £50 per annum for the first seven years, £75 per annum for the second seven years, and £100 per annum for the third period, towards the cost of the wages of the men employed in handling the clinker from the furnaces. The lessors agree to supply steam to the clinker works drying room at a price to be agreed, to lay cables to the works, and supply energy at 1d. per unit. It is considered that by the adoption of the foregoing scheme a total saving of £1,006 per annum will be effected, less labour costs being involved in delivering the clinker to one spot, where it will be cooled and used immediately, instead of having to be spread out to cool, and the present payment to the contractor for removing the clinker will be done away with. In addition to this estimated saving, the Council will have the advantage of a large consumer of electricity, whose supply will involve very small distributing costs, and also a consumer of the steam from the destructor. In a further report, the Committee notify that it has decided (subject to the usual sanction) to hold an electrical exhibition in the King's Hall at the Baths, about the first week in November.

ISLINGTON.—The Lighting Committee of the B.C. has recommended that new plant, &c., be obtained, to cost £15,500 as follows: one 1,500-KW. turbo-alternator, including turbine, alternator, exciter, condenser, pumps, &c., £9,000; foundations, £250; steam pipes, hot feed apparatus, &c., £1,500; one cooling tower capable of dealing with water for the above, £3,750; motors, fans, piping, &c., £500; contingencies, £500. The Committee, in bringing forward the recommendation, states:—"Islington at the peak end of the load last winter had only 33 per cent. reserve. Since the maximum load of last year was attained, an equivalent of 5,000 lamps, or about 150 KW. has been connected, in addition to which the department has recently received an application for an extension for supply to the Post Office premises in Upper Street of 250 KW." The Finance Committee recommend that the consideration of the proposed extensions be postponed until the accounts of the undertaking for the year ended March 25th, 1905, are submitted.

SOUTHWARK.—A meeting of the B.C. on 26th inst., throws some light on the state of affairs existing at present regarding the municipal E.L. undertaking. A question was asked as to what the loss was on the undertaking. The town clerk said that "in view

of the fact that the Council was opposing certain electric light companies' Bills, it was not advisable to give the information asked for." A notice was also given by a member, that at the next meeting he would move a resolution to sell the scheme as a going concern, in view of its heavy cost to the ratepayers.

The County of London Electric Supply Corporation has made a further offer to the B.C. to supply energy; provided the Council is prepared to adopt a comprehensive scheme of public lighting involving, say, a minimum of about 200 arc lamps or their equivalent in side street lamps, the company will give the following reduced terms:—1½d. per unit for all-night lighting, and 1½d. per unit for half-night lighting. The offer is to be considered by a joint committee consisting of the Works and Depôt and Electric Light Committees.

In a further report, the Lighting Committee states that it has decided to engage Prof. Kennedy, at a fee of £75, to report upon the foregoing extension scheme.

Maryport.—At the last meeting of the U.D.C. it was reported that the E.L. order had been revoked, and this action was characterised as unfair, seeing that a new dock and tramway scheme is under consideration.

Mexico.—The Mexican Light and Power Co., which owns extensive electric light and power rights in Mexico, is now engaged in building a great dam and power houses to enable it to supply Mexico City and other districts. The venture, says the *Financial Times*, owes its origin to Dr. F. S. Pearson, the American engineer, who had his attention attracted to the Tenango and Necaxa Rivers, in the State of Puebla, 100 miles away from Mexico City. The Necaxa and Tenango are not very considerable rivers, but, at short distances from their confluence, there are great falls on both streams. On the Necaxa there are two, not far apart, the upper, over a wall of rock 300 ft. high, and the lower over a sheer precipice of 750 ft. The channel of this stream above the first fall, lends itself to the construction of a great reservoir, in building which the town of Necaxa was "drowned out." To be allowed to do this it was arranged that a new town should be built on land purchased by the company. The dam will be about 171 ft. high, and the reservoir, when full, will contain about 12,000,000,000 gallons of water. Just above this dam the flow of the Tenango is diverted into the Necaxa, by means of a dam built across the former and a tunnel between the two. The power house is situated below the upper or 300-ft. fall. The tunnel takes the water from the river above the fall to the edge, where it is delivered into six great pipes to the wheels in the power house. These will produce 40,000 H.P.

The transmission will be by two independent lines of copper cable, carried on steel towers for the 100 miles intervening between the river and the City of Mexico, and thence 75 miles still further to El Oro. On the main lines the current will have a voltage of 60,000, which will be reduced by transformers to 6,000 volts, and within the city still further, to meet commercial requirements. At El Oro the equivalent of 10,000 H.P. is contracted for to the mines of that district. The sale at this point alone is expected to yield enough to pay the company's expenses and fixed charges. In Mexico City the remainder of the energy to be generated by power-house No. 1 will be divided between the lighting plant and various industrial concerns. As the whole output of this plant will be absorbed, work has been commenced upon the erection of a second power-house below the lower falls. This plant will have a capacity of 35,000 H.P., and will be completed in two years. From it will be run the City of Mexico Tramways and works in the district, which cannot be served from the power-house now nearly completed. Other sources of water-power in the neighbourhood of those now held, have been acquired by the company, and it is proposed to keep pace with the demand by constructing new generating plants as occasion requires. It is thought, however, that the requirements of the district will be fully met by the second installation until 1910.

Newcastle-on-Tyne.—The Electric Supply Co. has reduced the price of energy from a maximum of 4½d. per unit to a flat rate of 3⅔d. per unit, less 5 per cent.; meter rents have also been reduced to 1s. 6d. per quarter, up to 15 8-C.P. lamps, to 2s. up to 30 lamps, and to 2s. 6d. up to 50 lamps.

New Zealand.—AUCKLAND.—The proposal of the Auckland Electric Tramways Co. to supply electricity to the City Council for lighting and power purposes, was submitted to the Council a short time ago, for further discussion. The Streets Committee recommended that the company should be asked to quote the price at which it would supply energy in bulk at the company's power house, and for the use of its poles throughout the city, and also for the supply distributed. This recommendation was adopted. The question of the appointment of an electrical engineer was also dealt with, but referred back for further consideration. The recommendation of the Committee stated that the salary of the engineer, to be appointed, should be at the rate of £350 per annum, and that applicants be required to show that they have had at least from three to five years' power-house experience.

DUNEDIN.—Our New Zealand correspondent sends us the following information:—The deed of agreement between the Corporation and Messrs. Noyes Bros., by which the latter undertake to complete for an estimated sum of £40,000, the construction and equipment of the Waipori electric power and transmission scheme, has been signed. This sum refers to the estimated cost of the work proposed to be carried out by the Waipori Co., at the time it sold out to the Corporation, and embraces the following:—Construction of power station for 2,000 KW. of plant; generating plant, consisting of two 1,000-KW. generators, two exciters, seven transformers, and switchboard, as embraced in the contract let to the General Electric Co. by the Waipori Co.; water-power plant, consisting of two Pelton wheels for driving the generators and for two driving the exciters, together with all necessary fittings as embraced in the contract let to the Pelton Wheel Co.; equipment, such as station wiring, lighting, fittings, crane, &c. The power station building is to be built of concrete. The overhead power transmission line, starting at the power station at Waipori Falls, *vid* Berwick across country to the sub-station contiguous to Dunedin, situated at Halfway Bush. The supports of this, will consist of steel poles spaced on an average of 12 to the mile. The line will consist of three wires of No. 3 B. and S. gauge. The above estimate includes all payments made and to be made to the Australian General Electric Co. and the Pelton Wheel Co. in connection with their existing contracts. Mr. E. E. Stark, formerly electrical engineer to the Waipori Falls Electrical Power Co., in January last offered his services to the Corporation as consulting engineer in connection with the project recently taken over by the city. The Tramways Committee did not bring the matter before the Council until the negotiations with Noyes Bros. had been finished. Mr. Stark, however, withdrew his offer previous to the Council's decision in regard to the agreement.

Partick.—In our last issue we gave some extracts from the report on the year's working of the Stepney B.C. undertaking, prepared by the electrical engineer, Mr. W. C. P. Tapper, in which the average price received—2·11d. per unit—during the past year was stated to be the lowest of any undertaking in the United Kingdom without a traction supply. Mr. H. B. Maxwell, the burgh electrical engineer at Partick, informs us that his department received an average price of only 1·76d. per unit sold, which is a figure considerably below that realised at Stepney.

Penrith.—Messrs. J. & J. Enright have asked the U.D.C. if it is prepared to consider the transfer of the prov. order, on the understanding that the costs are repaid to the Council. The matter has been referred to a committee.

Rawtenstall.—The T.C. has decided to obtain a supply of energy for a period of five years from the Lancashire Electric Power Co.

Reading.—Mr. A. T. Cooper, managing engineer to the Electric Supply Co., has issued a very neatly got up pamphlet in order to give intending consumers general information regarding a supply; the advantages and cost of electricity as applied to lighting, power and heating purposes are clearly set forth. A revised list of charges for energy is to come into force on July 1st next, as follows:—For lighting purposes (at 200 volts).—To consumers using 1,000 units and under during the half-year ending June 30th or December 31st, 6d. per unit, with a minimum charge per quarter of 5s.; more than 1,000 units but not exceeding 2,500 units during the half-year, 5d.; more than 2,500 but not exceeding 5,000 units, 4½d.; over 5,000 units but not more than 7,500, 4d.; more than 7,500 units but not over 10,000, 3½d.; and to consumers using more than 10,000 units during the half-year, 3d. per unit. Meters are supplied free. A special rate of 3d. for basement lighting by separate meter, for which a rental of 3s. 6d. per quarter will be made, is to be adopted. For motive power:—All demands up to and including 4 B.H.P., supplied at 200 volts D.C., 2d. per unit; with a minimum charge of 7s. 6d. per quarter which includes a meter rental of 3s. 6d.; for all demands above 4 B.H.P., supplied at 200 or 400 volts at the company's option, 1½d. per unit; with a minimum charge of 10s., including a meter rental of 3s. 6d. For heating, &c., 1½d. per unit, with a minimum charge of 5s. per quarter, no charge for meter rent is to be made. Special terms will be quoted for long-hour supply.

Rotherham.—The last annual report on the electricity undertaking of the Corporation states that the gross profit was £6,240, against £6,068 in the previous year. The net profit amounted to £2,580, but from this £1,847 was set aside for renewals and depreciation.

Sheffield.—Mr. S. E. Fedden, general manager and engineer to the Corporation Electric Supply Department, took the opportunity at the Easter vacation, when the power users in Sheffield would probably be overhauling their plant, to issue an attractive leaflet drawing attention to the facilities and economies which now exist for driving by electric power off the Corporation mains. There is over 4,000 H.P. of electric motors now connected to the Corporation supply, and these vary in size from ¼ to 120 H.P., and are running every class of machinery.

South African Notes.—POTCHEFSTROOM.—In all probability a large sum of money will be spent on electric lighting and other work, at the Potchefstroom military cantonments, during the next financial year.

CAPE TOWN.—A large number of new underground feeder cables have been run from the Dock Road station to various parts of the town, and many overhead lines will consequently be dismantled. A large demand for electric power has lately arisen near the Opera House owing to large buildings being constructed in the vicinity. The new City Hall alone will have some 1,700 lamps installed.

Stafford.—The T.C., on April 27th, reduced the price of energy for power to 2½d. per unit, subject to the following discounts:—Under 200 units per quarter, 2½d. per cent; over 200, 50 per cent.; with a minimum charge of £2 per quarter.

Southport.—The gross profit of the Electricity Department for the past year is £14,771, against £14,573 in the previous year, an increase of £198. The net profit is £3,356, against £3,616, a decrease of £260. Out of the profit of the past year £2,500 has been paid in aid of the rates. As compared with the previous year, the Committee has suffered a reduction of income of £300 from sale of energy to the Tramways Committee and the Tramway Company.

United States.—Elgin, Ill.—After 17 years' running of the town's electric lighting plant by the municipality, the Council has come to the conclusion that its operation is a failure, and has resolved to negotiate with the traction company to maintain the street arc lamps at a cost of $58 each per annum. The chairman of the Finance Committee has given some figures as to the cost of the plant to the *Electrical World and Engineer*, and shows that, during the 17 years' working, $16,356 has been received from private lighting, and incandescent service to the city he estimates at $12,000—a total income of $28,356; the total expenditure, including purchase price ($25,546) amounts to $306,053. After deducting the income, together with an allowance for the present worth of the plant of $100,000, from this amount, a balance remains of $177,697. This shows an actual expenditure of $71 per public arc per year. The lowest estimate of the value of the plant raises the cost, however, to $96 per year. The traction company, it is stated, may use the city plant. The present installation of 247 arc lamps is to be supplied at $58 per lamp per annum, additional lamps up to 350 at $48, and in excess of this at $42. Energy for incandescent lamps is to be supplied to the Council at 4·66 cents per kw.-hour. To business houses the rate is to be 20 cents, and to dwellings 15 cents per kw.-hour, a sliding discount scale to 40 per cent. being provided for both classes of service.

York.—The Corporation Electricity Committee reports that the past year's working of the undertaking has resulted in a net deficit of £2,946.

TRAMWAY AND RAILWAY NOTES.

Belfast.—The paviors who went out on strike have resumed work again, a satisfactory arrangement having been arrived at. A very intricate piece of special work at the entrance of the Sandy Row depôt has just been completed, weighing close on 50 tons. The street is very narrow at this point, and there are 20 entrances to the sheds. The lay-out was built up at the works, and the whole thing when it arrived had only to be bolted up in position. This special work was supplied by Messrs. Hadfield's Steel Foundry Co., Ltd., Sheffield, and is made of "Era" manganese steel. The contractors, Messrs. J. G. White & Co., London, have now exactly six months in which to convert the system to electrical traction.

A motor rail service, the first to be introduced into Ireland, was inaugurated on Monday on the Belfast and County Down Co.'s system between Belfast and Holywood. The new service has been instituted primarily to compete with the prospective electric tramway system which the Belfast Corporation is introducing.

Birmingham.—On Saturday last an electric tramcar, which was proceeding from Yardley to Birmingham, suddenly burst into flames. The passengers were alarmed, but managed to scramble out without injury.

British Columbia.—According to the *Morning Post*, the British Columbia Electric Railway Co.'s great water-power enterprise at Coquitlam has now been completed by the successful boring of its 2½-miles water tunnel, which puts at the disposal of the company 35,000 h.h.p. The work was commenced in July, 1902, and the engineers have accomplished their task in three months less than the allotted time. The tunnel, which runs out of Lake Coquitlam into a smaller lake called Lake Beautiful, passes under a spur of the Cascade Range of the Rocky Mountains, 3,400 ft. in height, has a fall of 32 ft., and is 12,775 ft. in length, with dimensions 9 ft. × 9 ft. From Lake Beautiful to the power house on Burrard Inlet, an arm of the Pacific Ocean, in which is situated Vancouver Harbour, the fall is 410 ft. From thence the power is conveyed by cable, carried high over navigable waters by twin steel towers, built in England, to the railway company's sub-station.

Chester.—The Chester T.C. had under consideration at its last meeting the alternative of extending the electric tramway system, at a cost of about £17,000, or purchasing motor-omnibuses. The city electrical engineer, in a report on the subject, expressed his belief that the electric tramcar had little to fear from the motor-omnibus. That the latter had been greatly improved, he said, could not be denied, and there was every reason to believe that its improvement could be carried still further, but its field of usefulness was not in the same category as that of the electric tramcar. Its working expenses were so heavy that it was difficult to see how it could profitably be introduced into such towns as Chester. Tramways giving a 5 to 10-minutes' service could be worked more efficiently and more cheaply than motor-'buses giving the same service. A motion was made at the Council meeting to extend the electric tramway system. This was met by an amendment in favour of motor-omnibuses, but the original proposition was carried by a large majority, only 5 voting for the amendment.

City and South London Railway.—On May 1st this railway made important reductions in fares.

Continental Notes.—Italy.—Work is approaching completion on the the construction of the electric tramways from Rome to Frascati and the Chateaux Romains, and it is hoped to have the lines open for traffic by the summer.

From the *Board of Trade Journal* we learn that there are several projects mooted for electric tramways in the Venetian provinces. One, which would be undertaken by a Berlin firm, is to construct branch lines starting from Venice, Padua and Treviso in different directions, chiefly through districts not traversed by the railway. At Verona there is a project to build an electrical railway to pass through Lazise to Riva di Trento, apparently to join the main line of the railway. The Belgian company, which has the concession for running the horse tramways in Verona, will transform them into electrical lines. The energy will be derived from the River Milani, which will provide sufficient power not only to propel the carriages in the town, but also to transform the steam tramway between Verona and Cologna into an electrical one. Other are under discussion at Vicenza, Udine and Belluno, and as waterfalls are plentiful in the Venetian region, there will probably be a great development of electrical lines in future.

France.—A company has just been formed at Lille, with a capital of £480,000, to be known as La Compagnie du Central Electrique du Nord, to construct and work a system of electric tramways in the Nord and Pas de Calais departments.

Spain.—The Biscay Electricity Co. has applied for a concession to run an electric tramway in Bilbao for the carriage of goods.

A concession has been granted to put down a plant to utilise the water-power of the River Segre, at Foral, in the generation of electrical energy for a projected electric tramway between Lerida and Puigcerda.

Last September, at the station of the Société Générale de Tramways Electriques en Espagne (Madrid), two generators of 625 kw. were placed out of service owing to the undermining of the foundations, thus placing the company in an unfavourable position for the supply of energy. As the remaining power available was insufficient for the requirements of the tramway service, the company was compelled to make arrangements with the Compagnie Madrilène d'Electricité for the supply of power. The necessary alterations and other works are now in progress, and are expected to be completed in June.

Belgium.—After a period of gradual transformation from horse to electric traction during 1902 and 1903, the entire network of the Compagnie Générale des Tramways d'Anvers was finished and set in full operation, so that 1904 was the first complete year under the new *régime*. The effect of the conversion, which relates to a total length of 33½ miles, is shown by an advance in the gross receipts from £87,000 in 1902 to £132,000 in 1903 and £167,000 in 1904. A Royal decree has been issued sanctioning these extensions to Vieux-Dieu, Merxem and Deurne respectively, and when these have been constructed the track will represent a total length of 38½ miles. The net profits for 1904 amount to £40,970, and a dividend at the rate of 4 per cent. has been declared on the ordinary capital.

Germany.—The Grand Berlin Tramways Co., which has in operation 309 miles of tramway reckoned as single track, carried over 332 millions of passengers last year, as compared with 312 millions in 1903. According to the company's report, the working expenses largely increased, the percentage amounting to 55·33 per cent. of the receipts as against 53·88 per cent. in 1903. The large advance in expenses is mainly attributed to the increase in salaries and wages, and the outlay for benevolent purposes and liabilities, permissive and compulsory benevolent charges alone absorbing over £29,200. After providing for depreciation, the accounts show net receipts totalling £434,879, and a dividend has been declared at the rate of 7½ per cent. on a share capital of £5,041,200. The tax payable out of gross revenue to the Berlin municipal authorities and suburban communes amounted to £113,346, as compared with £108,843 in 1903, while the Berlin authorities also participated, in accordance with existing agreements, in the net profits to the extent of £5,987, as against £16,941 in 1903. In addition to ordinary passenger journey tickets, season tickets are largely in use on the tramways, and the number of journeys travelled by owners of the latter class exceeded 61 millions as compared with 58 millions in the previous year. The company is now engaged in litigation with the Berlin municipal authorities in regard to the proposed extension of the elevated and underground electric railway from Potsdam Platz to the Spittelmarkt—an extension which the company consider will cause competition, and prejudicially affect its gross receipts by £125,000 per annum.

Edinburgh.—It is stated that the Dolter Electric Traction Co., Ltd., who have been giving an exhibition in the city, have made an offer to the T.C. to equip the Gilmore Place line with their surface-contact system, and ask no payment for one year. At the end of the period, if the Corporation is dissatisfied with the results, the apparatus will be removed. If satisfied, the cost of installing the system will then be reckoned with.

Folkestone.—The electric tramway question has again been revived by the receipt by the T.C. of an offer from the Traction and Power Securities Co., Ltd., to construct tramways and to repay up to £1,200 the sum the Council has expended in obtaining the order, and £15,000 in respect of road widening. The route proposed is from the crest of the Downs on the Dover Road, through the town to Cheriton, over Shorncliffe Camp to Hythe, with a

prospective extension to Lydd and along the South Coast. The Council on April 26th referred the matter to a Committee, which was also instructed to consider the question of advertising for tenders for the construction of tramways, to be leased when completed.

Glasgow.—By way of reducing the ranks of the unemployed each winter, the Tramways Committee of the T.C. has instructed the general manager to delay as much painting work as practicable until the late autumn.

The general manager has been asked to report as to the steps taken to protect the tramcar drivers from the severity of inclement weather.

Mr. Dalrymple recently reported to the Tramways Committee an interview he has had with the engineer to the electricity department, regarding the supply of electricity by the tramways department to the electricity department for the winter peak load for 1905-6. He further reported that the tramways department might during next winter supply the electricity department with all the power that could be spared from the complete load of three engines after meeting the tramways requirements, and that the price of such energy should be at the rate of 1½d. per unit. The Committee approved of this arrangement.

Gloucester.—The Corporation tramways show a gross profit of £4,166 as the result of the first 11 months' working, and after applying £3,921 to meeting interest on capital, £245 is carried forward to next year's account. This, however, is exclusive of the interest and repayment of a loan of £26,000 for the purchase of an old system of horse tramways from the company to which it belonged. In all, 3,546,852 passengers were carried; the cars ran 449,320 miles; the undertaking paid £2,831 to the electricity department of the Corporation and £226 to the rates.

Heywood.—A conference which took place last week, between representatives of the Rochdale, Heywood and Bury Tramway Committees, resulted in the drafting of a preliminary working arrangement. Former negotiations entered upon in the hope of securing a *modus vivendi* were abruptly broken off. The terms suggested will be submitted to the full committees of the three authorities at a future meeting. The suggestion is that Heywood shall construct and maintain the track; that Rochdale and Bury shall furnish cars and employ a staff sufficient for a 15 minutes' service, charging 4½d. per car-mile run. Heywood will provide the energy, Rochdale and Bury becoming responsible for the overhead equipment. It is proposed that this arrangement shall continue for three years, subject to six months' notice on either side. Should any dispute arise which does not admit of mutual settlement, it will be referred to an independent tramway manager, whose decision is to be final.

Leeds.—The Tramway Committee has decided to recommend the City Council to allocate £50,000 of the tramway profits to the relief of the rates, as compared with £52,000 a year ago.

Liverpool—Southport Electric Railway.—The conversion of this railway to electrical working has amply justified itself, and the results must be very satisfactory to the Lancashire and Yorkshire Railway Co., and to the contractors, for the abnormally heavy Easter traffic between Liverpool and Southport was dealt with in a most expeditious and commendable manner. The traffic has grown to such an extent that an additional transformer station is now proposed, for which a site at Hall Road has been chosen. For shunting purposes extra sidings are proposed at Hightown. In Blundellsands there is some alarm lest Waterloo and not Hall Road should be made the terminus for the 10 minutes' service, which might well be extended to Hightown on Saturday afternoon during the rifle shooting season at Altcar Rifle Range. This range, one of the most famous in the country, is now served by an excellent service of electric trains from both Southport and Liverpool, and all the stations on the electric railway are now much busier than before the inauguration of the electric service. A still further development in traffic will follow the junction with the Overhead Railway at Seaforth, preparations to that end being in steady progress. Seeing that the Liverpool and Southport Electric Railway has proved so great a success in full and complete working, it is by no means improbable that a similar service will be inaugurated to Preston at no distant date. The electrification of the Liverpool—Southport line is considered to be the prelude to more extensive schemes, and will, doubtless, be the precursor of electric lines leading to all the main centres, which will sooner or later feel it imperative to follow suit in order to conform with the demands of modern requirements.

Manchester.—A deputation of gentlemen representing the Municipality of Detroit, U.S.A., was in Manchester last week, making inquiries as to the working of the municipal tramways. Detroit, it appears, is at the present time agitated on the municipalisation question. Very full information was given to the visitors respecting the working of the Manchester tramways, and they left expressing high admiration of the system and their obligation for the information afforded them. They were especially interested to hear of Manchester's financial success.

New Zealand.—WELLINGTON.—An overdraft of about £30,000 has accrued during the construction of the tramways. The Mayor recently explained that £6,000 was estimated by the electrical engineer as the total cost of Customs duties on the imported materials, but the actual amount paid was £16,100. In explanation it was stated that the tariff was very difficult to interpret. Wood blocks, tar, &c., cost an extra £2,000, and extra cars would cost another £7,000. On office and engineering expenses, legal costs, interest payments, &c., there was an overdraft of £6,338. For necessary alterations to the overhead lines—telegraph, telephone, and electric light—the cost was £11,841 instead of the estimate of £8,000; a total in all of £29,979.

Penge.—The British Electric Traction Co. has successfully disposed of the Beckenham white elephant, but there were left certain ends of line abutting on Beckenham which, if constructed, would have been of no use to the tramway service, and would certainly have been constructed at a loss. The Penge Council was not disposed to alter the agreement without some consideration, and this has now been given in the form of an undertaking to lay the South Norwood to Penge extension during the summer, and also to pay the Penge Council a further sum of nearly £5,000.

Pensnett.—A child, aged two years, was accidentally killed on the tramway on Wednesday last week. At the inquest on Friday it was stated that no blame could be attached to the driver.

Rochdale.—The working of the electric tramways for the past year has resulted in a loss of nearly £9,000.

Rotherham.—During the past year the gross profit on the Corporation tramways undertaking amounts to £5,033 17s. 9d., and the net profit to £603 5s., which is to be placed to the renewals and reserve fund.

St. Helens.—A strike was begun on Thursday last week by the employés of the St. Helens and District Tramways Co., against a refusal by the company to grant an increase of pay, in fulfilment—as the men say—of a promise made to them some time ago. The company says that it is impossible to concede the men's demand at present. Should the strike continue, the service of cars will probably be curtailed in some sections; in others it may have to be suspended. It is hoped, however, that negotiations will lead to a settlement. The men are said to be organising an opposition omnibus service. On Saturday morning not a single car had left the sheds up to 9.30. Many workmen, sympathising with the strike hands, walked long distances to work in the early morning. During the forenoon five or six cars were turned out on the Rainhill, Prescot, and Knotty Ash section; on other routes none at all. The cars were all withdrawn at dusk, fears being entertained of damage by stone throwing. Some of the cars were driven by the manager, cashier, and other members of the office staff. The trade unions have ordered a boycott of the cars, and several unpleasant incidents have occurred. One car was stoned, and in another the window was smashed by a woman, who flung her clog through it.

On Saturday the representatives of the men interviewed the directors of the Tramway Co. with a view to a settlement; but, while the latter were willing to grant all the demands of the men concerning details of working, they declined to make any advance on the initial question of wages. What the men ask for is that conductors shall be paid 4d. per hour on entering the service of the company, rising to 4½d. after six months' service, with a maximum of 5d.; and that drivers shall start at 5d., and attain a maximum of 6d. The directors offer to meet the requirements of the men in six months' time and to discuss an advance, and, failing to come to an agreement, to refer the matter to arbitration. This decision was communicated to a meeting of the men, who unanimously decided to remain on strike. The strikers further ask for a guaranteed average of 60 hours per week, to be worked in six days, and that all spare men shall receive 2s. per day for those days when they are not working; that Sunday and holiday labour shall be paid for at time and a quarter; that sufficient time be allowed for each journey to be made without infringing the Board of Trade regulations; that drivers and conductors be allowed 15 minutes to sign on, and conductors allowed 10 minutes to pay in. Several minor accidents have occurred since the cars have been run by an emergency staff, and the strikers have picketed the town. In some cases, the cars ran from terminus to terminus without a single passenger. The strikers state that the amounts asked per hour are the original terms, and that they were in force three years ago. Some of the men have been receiving the maximum stated above, but there are others who, being entitled, are not receiving it, and they have struck in sympathy with those whom they consider underpaid. On the question of pay, the men insist on their demand.

Owing to the strike, the tradespeople of St. Helens are experiencing considerable loss in business, as the borough is a centre of a great population, to the bulk of whom the electric tramcars is the most convenient means of travelling.

On Monday the strikers held a meeting and discussed the question as to accepting arbitration, as offered by the directors. It was ultimately decided to accept arbitration on the basis of the average wages paid to drivers and conductors in other towns throughout the county, the local conditions in St. Helens not to be considered. Only a few cars were running on Monday.

On Saturday a fatality occurred at St. Helens in connection with the tramways. An electric car had proceeded a few yards past Rainhill Station on the road to Prescot, when the trolley head got locked in the overhead work. Mr. W. Williams, master of the Prescot Union Workhouse, who had just boarded the car, had scarcely reached the top deck when he noticed the accident and began to climb down. The car proceeding from its own momemtum, the trolley pole was wrenched off, dragging with it the cast-iron standard. This dropped on the head of Mr. Williams, killing him outright. Mr. Richard Prescott, a member of the Whiston D.C., was travelling on the top and was injured on the head. Owing to the strike which is

proceeding at St. Helens, there were very few passengers on the car. At the inquest a verdict of "Accidental death" was returned, no blame being attached to the driver or conductor.

South Africa.—Rhodesia.—Interviewed at Livingstone on the construction of the bridge over the gorge of the Victoria Falls, Sir Charles Metcalfe stated that he was considering a project to electrify the line from the bridge to the new township, so as to run a service of trolley cars.

Kimberley.—The *Transvaal Critic* states:—De Beers have laid eight miles of electric tramways between Kimberley and Alexandersfontein, and are defraying the whole cost of construction and plant purely for the benefit of the inhabitants.

Southport.—The gross income from all sources on the Corporation lines during the past year amounted to £17,906 11s. 1d., against £17,646 13s. 1d., an increase of £259 18s. The working expenses were £10,756 2s. 7d., compared with £10,986 4s. 8d., decrease £230 2s. 1d.; the gross profit being £7,150 8s. 6d., against £6,660 8s. 5d., or an improvement of £490 0s. 1d. The total expenditure is £17,891 9s. 9d., and there is a small surplus of £15 1s. 4d. The deficit on the previous year of £341 0s. 7d. has been turned into a profit.

Wednesbury.—It is announced once more that the difficulties between the Corporation and the tramway company respecting the reconstruction and electrical equipment of the line between Wednesbury and Darlaston have been overcome, and that the necessary work is to be immediately commenced.

TELEGRAPH AND TELEPHONE NOTES.

Caroline Islands.—It was officially announced by the German Administration, on 27th ult., that an office had been opened to International traffic at Yab (Carolines). This office is connected by cable with Menado (Celebes), as well as with Guam by a cable belonging to the Germany-Holland Telegraph Co.

Glasgow Telephones.—Mr. A. R. Bennett has been retained by the Corporation Telephone Department for another year as consulting engineer at a fee of 100 guineas.

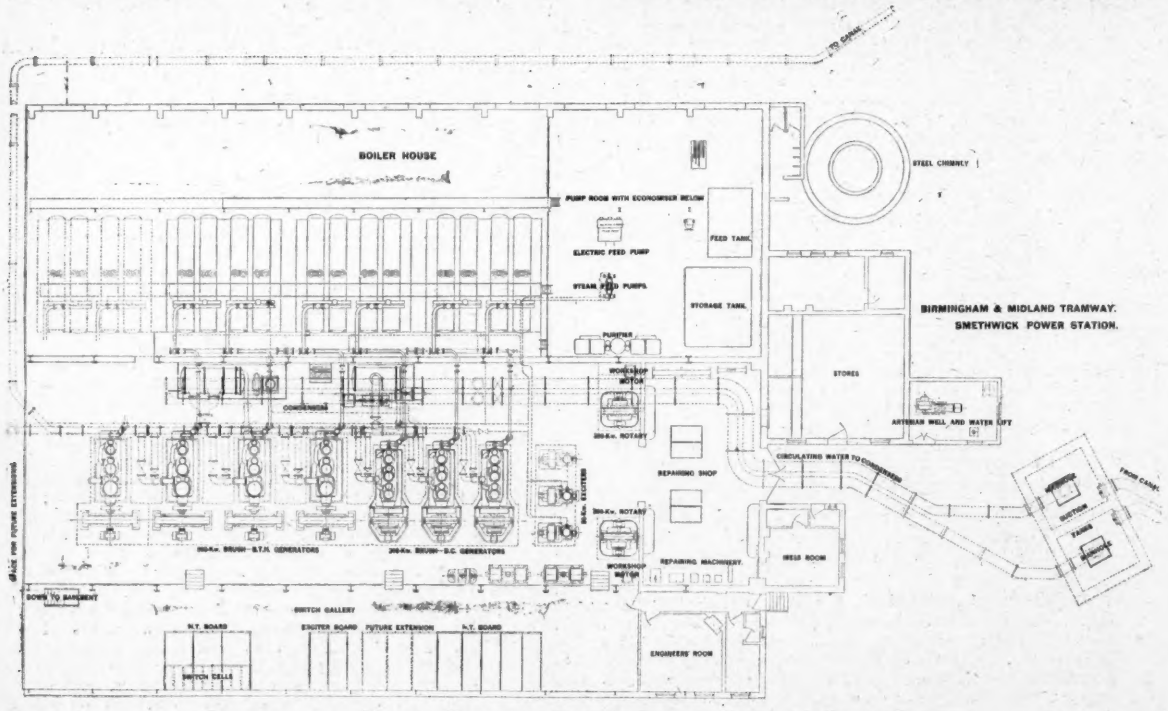
Huddersfield Telephones.—The Postmaster-General has withdrawn the licence granted to Huddersfield T.C. for the establishment of municipal telephones, on the grounds that no steps have been taken in the matter.

Hull Telephones.—The Telephones Committee of the Hull Corporation has had under consideration the agreement entered into by the Postmaster-General for the purchase of the National Telephone Co.'s undertaking. In an exhaustive report the town clerk explained how the agreement would affect the Corporation as the owner of the municipal telephone system. The Committee arrived at the opinion that it was not desirable that such agreement, in its present form, should come into force, and that steps be taken to oppose the agreement. The Committee is strongly of opinion that, in order to enable the Corporation to recoup the capital expenditure incurred, the Postmaster-General should undertake either to purchase the whole of the plant in 1911, or to grant a renewal of the licence to 1927.

Korean Telegraphs.—Reuter's Tokio correspondent states that the agreement between Japan and Korea, giving to the former the control and management of the Korean posts, telegraphs and telephones, was published in the official "Gazette" on April 28th. This was confirmed by an official telegram on April 28th.

Neutrality of Cables.—According to the *Daily Mail*, Russian agents have been at work and have cut the cable between Hainan and Chinese territory, although the landing of the cable at both places is on neutral territory. This, if true, is another instance of offence against the laws of neutrality, and gives ground for belief that some part of the Russian fleet is at Hainan Island.

Telephones in Berlin.—According to a statement issued by the Postal Authorities, the number of subscribers in Greater Berlin at the beginning of April this year was 86,076, as recorded in the Telephone Directory, and of the total, Berlin alone is responsible for 69,000. The largest exchange is No. 1, with 13,538 connections; No. 4 occupies the second place with 12,884; and No. 3 has 10,503. The future No. 6 exchange in Korner Strasse is to be equipped for 20,000 subscribers.



Birmingham and Midland Tramways: Fig. 10.—Plan of Smethwick Power Station.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1)	Aug. 26, 1901	
Dominica-Martinique	May 7, 1903	
St. Lucia-Martinique	May 7, 1903	
Cayenne-Pinheiro	Aug. 18, 1903	
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	
Tarifa-Tangier	Jan. 18, 1904	
Closed { Vladivostok-Nagasaki	Feb. 9, 1904	
Closed { Port Arthur-Chifu	Mar. 9, 1904	
Jamaica-Colon	Jan. 5, 1905	
Martinique-Paramaribo	April 2, 1905	
Maranham-Ceara	April 6, 1905	
Bathurst-Bissao	April 22, 1905	
Bonny-Duala	April 25, 1905	April 27
Cape Haite-Mole St. Nicholas	April 28, 1905	
Landlines.		
Puerto-Barrios	July 28, 1903	
Kertch-Soutchoum	Sept. 27, 1904	

Turkish Telegraphs.—The Convention for laying the Kustenji-Constantinople cable, says the *Morning Post*, has been signed with the German Eastern Telegraph Co. The work of laying the cable will begin shortly.

British Motor-Boat Club.—The opening meeting of this club will take place to-morrow at the Sun Hotel Staging, Kingston-on-Thames.

THE BIRMINGHAM AND MIDLAND TRAMWAYS.

(*Concluded from page* 695.)

There are also installed in the engine house two 30-kw. steam-driven exciter sets, consisting of direct-coupled four-pole generators, giving 500 volts at 375 r.p.m. These were supplied by the Brush Co., who also supplied the balancing sets for use on the three-wire lighting system in the Smethwick area.

The balancers, two in number, are 30-kw. machines, running at 830 r.p.m.; there are also installed two 300-kw. rotary converters, fig. 13, each provided with three 110-kw. single-phase transformers and switchgear, of a similar type to that used in the sub-stations, which will be described later.

A small d.c. motor-generator is provided for supplying the station lighting at 250 volts.

Views of the engine room plant were shown in our last issue, and a plan and section of the power station are given in figs. 10 and 11 herewith.

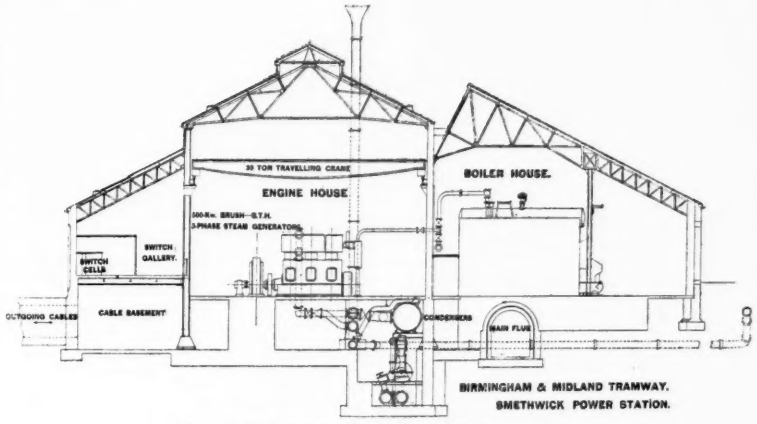


Fig. 11.—Section Through Power Station.

The condensing plant for the larger engines is of the Weir circular type, having 3,600 sq. ft. of cooling surface, the air pumps, condensed water pumps and circulating pumps being steam-driven. The plant is specified to deal with 37,500 lb. of steam per hour when maintaining a 26-in. vacuum. The circulating pump is of the direct-coupled centrifugal type, 48 in. in diameter, with a speed of 250 r.p.m.

For the 300-kw. engines, a surface condensing plant having 2,260 sq. ft. of cooling surface, is provided. This plant has a rated capacity of 22,500 lb. of steam per hour, with a vacuum ranging from 25 to 27 in. The air and circulating pumps are motor-driven, the former being a three-throw Edwards air pump, running at 200 r.p.m., and the latter a 19-in. diameter pump.

The circulating water is obtained from the canal, duplicate inlet-pipe lines, each 24 in. in diameter, being provided.

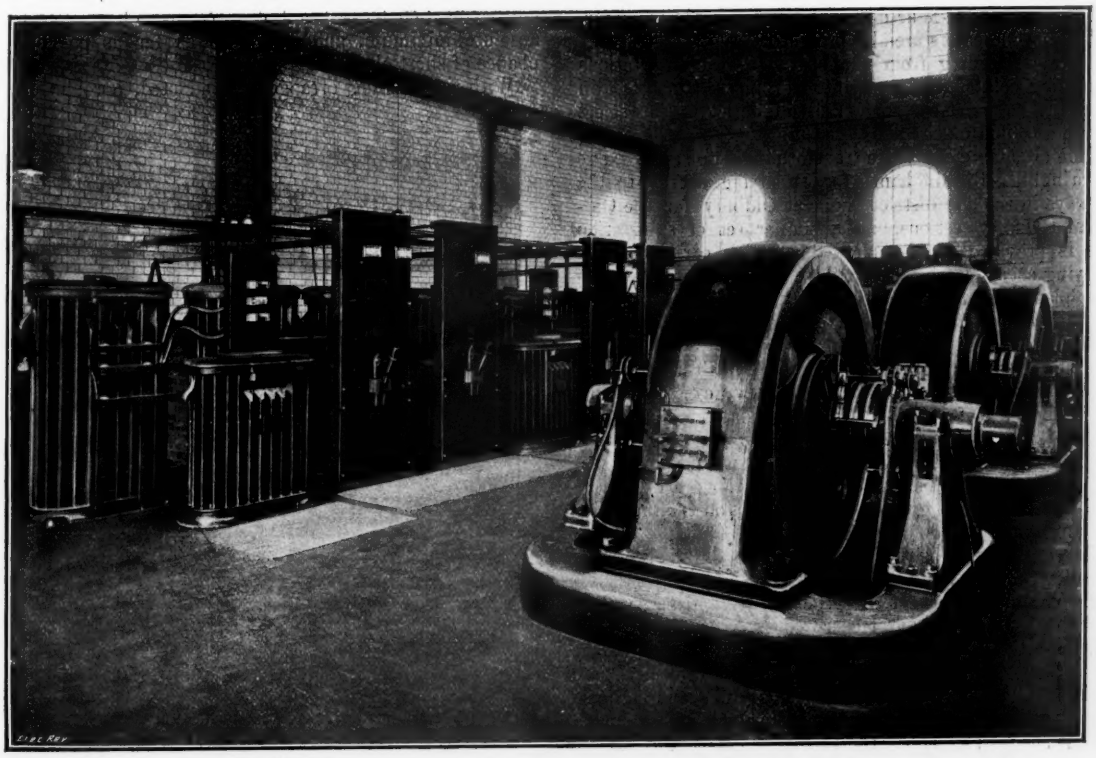


Fig. 12.—Springhill Sub-Station: Rotaries and H.T Switchgear.

The switchboard, which was supplied by the Brush Co., is mounted on a gallery extending the whole length of the engine house.

The direct current board is arranged to supply energy to the tramways in the neighbourhood, and also to the three-

wire electric lighting system in Smethwick. It is fitted with British Thomson-Houston registering and Elliott's Weston type recording instruments, B.T.-H. circuit-breakers,

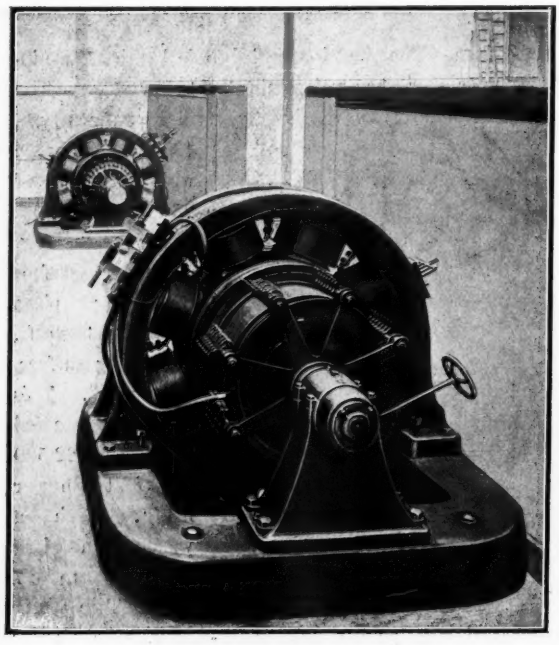


Fig. 13.—Smethwick Power Station: Rotary Converters.

switches, &c., all of which are mounted on black slate panels.

The extra high pressure board for dealing with the alternating supply at 5,500 volts to the sub-stations, is of the remote control type, equipped with B.T.-H. oil switches and circuit breakers, watt-hour-meters and measuring instruments. Kelvin watt indicators are also provided.

The cables leading from the boards to the sub-stations and feeding points are drawn into iron pipes, supported on racks, in the basement, and find an outlet to the street through a cable tunnel.

There are at present three transforming sub-stations, one at Springhill, Birmingham, for supplying energy to the tramways in the city district; one at Oldbury for the Oldbury and Dudley sections, and a similar set of sub-station plant is provided at the West Smethwick car depôt, for supplying energy to the shed and repair shops. The converter plant installed in the power house at Smethwick is for supplying high and low tension current in the Smethwick district, for power and lighting purposes respectively.

The Springhill sub-station is equipped with three three-phase rotary converters, each of 200-KW. capacity. The transformers are of the oil-cooled single-phase type, arranged in sets of three, each of 75 KW. capacity, for each rotary. The primary and secondary windings are wound for transformation from 5,500 to 340 volts, but various ratios can be obtained by connecting to intermediate taps on the primaries to compensate for drop on the feeders.

The high-tension switchgear is of the oil-break remote control type, as in the power station.

The main current entering the sub-station passes first through the high-tension feeder panels, then through the high-tension machine panels to the high-tension side of the transformers. The secondaries of the transformers are connected to a double throw-over switch, and are so arranged that the rotary converter is started at half-voltage; when it attains full speed, the full voltage is put on to the machine by throwing over the switch.

The cables for the direct-current side of the rotary converter are carried on rack insulators, in a subway under the machines, to the direct-current switchboard (fig. 15).

The machine switchboard panels for the direct-current side are fitted with watt-hour-meters, ammeters and circuit breakers of the British Thomson-Houston magnetic blow-out type; on the alternating-current side, the machine panels are fitted with an ammeter and a power factor indicator.

The sub-station plant is illustrated in figs. 12, 15 and 16, and the rotary connections are shown in fig. 14.

The sub-station at Oldbury is of a similar design to the above, but is equipped with three 100-KW. rotary converters.

The most noticeable feature in connection with the sub-stations is the fact that all unnecessary complications have been done away with, a most welcome and necessary

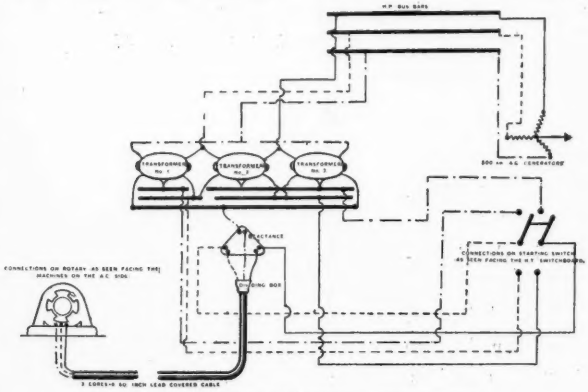


Fig. 14.—Diagram of Rotary Connections.

feature in connection with a sub-station, and, indeed, all central station plant.

The end sealing boxes on the H.T. incoming feeders are placed directly side by side with the H.T. feeder switches, but separated therefrom, as in the case of all H.T. switches in the station, by brick barriers.

Immediately in front of the H.T. switch cells stand the transformers, and in front of these, in turn, the H.T. control panels, as well as the small panels mounted on the machines, which carry the double-throw low-tension switches used for starting, the arrangement being clearly shown in figs. 12 and 16.

The negatives of the rotaries are tied solidly to earth, so that the D.C. switchboard is entirely single pole. The above arrangement enables all cable connections to be reduced to an absolute minimum, and eliminates as far as possible the chance of short circuits.

With the starting arrangement adopted, a rotary can be

Fig. 15.—Springhill Sub-Station: L.T. Switchgear.

placed on the line within from ½ to 1 minute under all conditions, and the effect on the voltage is inappreciable under normal conditions, and can hardly be noticed on the station lamps.

The double-throw field switches on the rotaries enable the correct polarity to be obtained under all conditions, thus eliminating any question of chance in connection with the proper polarity of the rotaries being obtained.

The cables within the Birmingham area are to the joint specification of Mr. R. A. Chattock, City electrical engineer, and Mr. A. J. Lawson, engineer to the tramways, and were supplied and laid by Messrs. Callenders. The low-tension cables are laid on the solid system; the high-tension cables between Smethwick and the Springhill sub-station are of the three-core, paper-insulated, lead-covered type, drawn into Sykes conduits, it being arranged between the company and the Corporation, that, in the event of a supply not being required inside Birmingham from the tramway generating station, after the lapse of the tramways lease in July, 1906, the high-tension cables shall be withdrawn, and that the low-tension cables, suitable for the tramway supply only, from the sub-station, are to remain. These cables were laid the distributors are three-core cables of ·125, ·05, ·125 sq. in. section, laid on the solid system in Doulton troughing, and were supplied by the British Insulated and Helsby Cables, Ltd., Mr. H. Arkell acting as their local representative.

Fig. 16.—Springhill Sub-Station: Transformers, Reactances, and H T. Switchgear.

The power house plant was supplied and erected by the Brush Co. — Mr. William M. Hind acting as their resident engineer; all the plant and material for the sub-station equipment was supplied and erected by the British Thomson-Houston Co., Mr. J. T. H. Legge, who acted as their resident engineer, having since been retained by the Birmingham and Midland Tramways Co. as their chief assistant engineer.

The whole of this installation has been carried out to the plans and specifications, and under the supervision, of Mr. A. J. Lawson, M.I.C.E., M.I.E.E., the consulting engineer to the Birmingham and Midland Tramways, Ltd., Mr. R. F. Browne, A.M.I.E.E., being the resident electrical engineer to the company, for all the electrical work.

Swindon Tramways: Views of Section Pillar, with Telephone and Fire Alarm Box, and of Standard Bracket Arm.—(See next Page.)

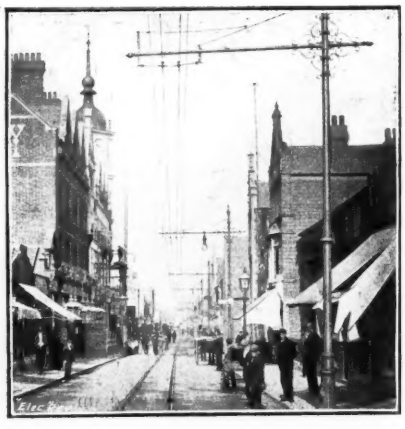
under the supervision of the city electrical engineer and his assistants.

The cables outside Birmingham comprise high-tension three-core cables of ·05 and ·1 sq. in. section to the Oldbury sub-station and the City section respectively; and low-tension tramway feeders, which were all drawn into Albion conduits. For the lighting network in the Smethwick area

To Mr. George Conaty, M.I.Mech.E., the engineering manager to the Birmingham and Midland Tramways Joint Committee, and to Mr. S. A. Mahood, A.M.I.E.E., the company's engineer in charge of the Smethwick power station, the sub-stations and the distributing system, we are indebted for the facilities kindly afforded to us on the occasion of our visit.

THE SWINDON CORPORATION TRAMWAYS.

The Swindon tramways, which were opened for traffic on Sept. 22nd, 1904, consist of some 4½ miles of single track, built to a gauge of 3 ft. 6 in., the contractors for the whole



View of Tramway in Regent Street.

of the track and overhead work being Messrs. J. G. White and Co., Ltd.

The whole system is single track, with passing places at convenient distances, there being no special work except the triangular junction at Wellington Street, opposite the G.W.R. station. The track work at the swing bridge over the canal in Fleet Street is, however, most uncommon, the approach from Fleet Street having a gradient of 1 in 10 for a short distance; this, combined with the peculiar position of the bridge with respect to the alignment of the track on each side, necessitated the rails being curved both horizontally and vertically to a somewhat small radius, to meet the rails on the bridge.

On portions of the tramways subjected to heavy traffic, and on steep gradients, the track is paved with granite setts; the greater portion of the track, however, is tar macadam paving, with a 4-in. granite sett margin each side of the rails. The concrete under the tar macadam takes an arch form, 6 in. thick under the rails and 3 in. thick at the centre of the track. Under the tar paving, a longitudinal trench 12 in. × 12 in., was excavated in the centre of the track below the level of the concrete and filled up with broken stone: this acts as a drain for any water accumulating under or near the

Span Wire Construction, Regent Circus.

track, openings being left in the concrete bed at intervals of a few feet, so that the water may pass through from under the paving.

The rails are to British standard sections, weighing 105 lb. per yard, on the straight, and 111 lb. per yard on curves. The rail joints are butted close, and are provided with 24 in. soleplates of the anchor type, of the same section as the rails, the 60 ft. rails also being anchored to the concrete midway between the joints.

The points for turnouts and special work are of manganese cast-steel, supplied by Messrs. Hadfield's, Sheffield; the turnouts are fitted with automatic and the special work with movable points. The crossings for turnouts are also of manganese steel.

The special work at the entrance to the car-shed was supplied by the Lorain Steel Co., of U.S.A., and is of their T-rail, built-up construction, with guards bolted on. This work is laid on sleepers and ballasted.

The bonds throughout the work are 0000 B. & S. gauge, "Crown" type, with ⅞ in. terminals, all joints being double bonded, and the track is cross bonded at the usual intervals and between the inner rails of turnouts. Special bonds of 61/16 S.W.G. flexible cable were used to connect up the ends of the track where it crosses the movable canal bridges in Regent Street, the rails on the bridges being bonded to the track by a flexible bond.

The greater portion of the overhead equipment is bracket-arm construction, but span wires have been used in one or two instances.

Twenty arc lamps were included in the contract, and have been erected on the bracket-arms. These were supplied by the B.T.H. Co., and are of the double carbon enclosed type, taking 2¾ amperes, burning singly, on a 220-volt circuit. Two 16-C.P. incandescent lamps are also fixed on ornamental brackets below the arc lamps, the lamps being con-

View of Car-shed.

trolled by a cylindrical two-way plug switch with fuses, fixed on the pole.

The trolley wire is 00 S.W.G. hard drawn copper, and is carried on the bracket arms by flexible bow-string suspensions.

The insulation is double throughout, the hangers, pull-offs, &c., being heavy gun-metal with "Verus" insulation. The frogs and crossings are of the straight under-running type, the section insulators being of the air-gap pattern.

The guard wiring is earthed to the poles at its termination, and at not greater intervals than every fifth pole where guard wiring is necessary, these poles being bonded to the rail by 00 wire.

The section and feeder boxes are fitted with four switches for the leads to the trolley wire, and two main feeder switches, all of the knife pattern with a quick break; a Garton lightning arrester is also fixed inside the box. Four 19/16 S.W.G. V-I-R lead-covered cables are carried from the feeder switches to the trolley wire.

The top of the section box carries a small cast-iron box containing the telephone, with which is combined a fire alarm for the Corporation Fire Brigade (see illustration, p. 733). The box is fitted with a door, with the usual glass disk, which is to be broken in order to give access to a bell-pull to ring up the station, when giving the alarm. The interior of the box is fitted with a telephone transmitter and receiver, which can be used by the police or tramway officials, who can give definite information respecting an outbreak of fire or breakdown of the tramway service. The telephone cables are run first to the generating station, where a large six-line

switchboard has been fixed with a change-over switch and various other instruments. A special telephone cable is laid from the generating station to the Town Hall, where a similar switchboard is fixed, with branch lines to the firemen, town clerk's office, &c.

The pilot and telephone wires, of 12 S.W.G. copper, are carried on porcelain insulators on the poles from the last feeder box on each route to the terminus.

As there are several places where it is not possible to see from one passing loop to the next, three sets of hand-operated signalling gear have been erected; these are small cast-iron boxes containing two 16-C.P. 250-volt incandescent lamps and two-way switches for operating the lamps. When a section is blocked, the signal lamps at each end are burning; to clear the block, the car conductor switches off the lamps in both boxes when leaving the section. In some cases a four-core cable is laid underground between the signal boxes, and in others the signal wires are carried on a small cast-iron bracket on the poles overhead, in a similar way to the pilot and telephone wires.

One set of Harison's automatic signalling gear provided with semaphore arms and coloured lamps, has also been erected.

Seven cars were supplied by Messrs. Dick, Kerr & Co., Ltd., for working the tramways. These are of the double-deck, single-truck type, with spiral reversed stairways, and are designed to accommodate 46 passengers (*i.e.*, 22 inside and 24 outside). The trucks are the Brill Co.'s 21 E type, and each car is fitted with two Dick, Kerr standard 6 A traction motors, capable of developing 37 H.P., and controllers of that firm's standard D.B.I. form "C" type, especially arranged with resistances for rheostatic braking.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—May 23rd. Six single-deck tramcars. See "Official Notices" to-day.

Brussels.—May 16th. The City Authorities invite tenders for electric cables and accessories. Specifications (1 fr. 50) at Rue Sainte-Catherine, 11, Brussels. Tenders to the College des Bourgmestre et Echevins.

Cork.—Year's supply of electrical fittings to the Cork Electric Tramways and Lighting Co. See "Official Notices" to-day.

Dartford.—May 24th. Lancashire boiler, piping, one 200-KW. steam dynamo, traction battery and reversible booster, main switchboards, &c., for the U.D.C. light railways. See "Official Notices" to-day.

Dublin.—May 15th. The Dublin Port and Docks Board is prepared to receive tenders for an electric generating station. Apply to Mr. John P. Griffith, M.Inst.C.E., East Wall, Dublin, for specifications &c., (deposit £5).

Edinburgh.—May 8th. Water-tube boilers for the electricity works. See "Official Notices" April 14th.

France.—May 14th. Tenders are being invited until May 14th, by the municipal authorities of Dax (Landes) for the concession for the electric lighting of the town during a period of 35 years. Tenders are to be sent to La Mairie de Dax (Landes), whence particulars can be obtained.

France.—May 15th. The Governor General of French West Africa, at Dakar (Senegal), is inviting tenders for the establishment of a central electricity station in the town, and for the construction of an electric tramway.

Heywood.—May 17th. Lancashire boiler, two 200-KW. steam dynamos, traction switchboard and feeders, and other plant for electricity works extensions. See "Official Notices" to-day.

Islington.—May 24th. Coal bunkers for the electricity works. See "Official Notices" to-day.

Keighley.—May 20th. Superheaters. See "Official Notices" to-day.

Kettering.—May 29th. Nernst lamps, posts, &c., for street lighting. See "Official Notices" to-day.

Leigh.—Mechanical stoker for a Babcock boiler. See "Official Notices" to-day.

Leith.—May 17th. Coal elevating and conveying plant, and boiler-house auxiliary plant. See "Official Notices" to-day.

London.—May 16th. The L.C.C. invites tenders for the erection and maintenance, for a period of 10 years, of a battery of 280 accumulator cells, having capacities of 645 ampere-hours at a 3-hour discharge rate, and of 450 ampere-hours at a 1-hour discharge rate. See "Official Notices" April 21st.

Rosario.—July 31st. The *Review of the River Plate* says that one of the alterations in the new electric tramways specification affects the date for sending in tenders, which is now to be July 31st.

Sunderland.—May 24th. Tramway stores. See "Official Notices" to-day.

Warrington.—May 13th. Condensing plant for the electricity works. See "Official Notices" April 28th.

CLOSED.

Aberdeen.—There were 24 tenders submitted to the Electric Lighting Committee for condensing plant for the Dee Village Works, and that of Messrs. W. H. Bailey & Co. (£1,036), is recommended for acceptance.

Aston Manor.—The following is a list of the tenders submitted for the electrification of the Corporation tramways, under Contract No. 6 (Mr. Robert Green, Assoc.M.Inst.C.E., Engineer):—

	Net amount of tender after deducting the value of old materials.
Geo. Trentham (accepted)	£51,236 3 9
Dick, Kerr & Co., Ltd.	51,849 1 10
Geo. Law	52,912 7 6
J. G. White & Co.	52,857 15 9
Underwood & Bros.	53,897 7 6
Griffiths & Co., Ltd.	54,073 9 6
Graham & Sons	54,162 0 0
Krauss & Sons	56,552 5 0
John White, jun.	59,112 7 7
Geo. Holloway	61,572 5 0
Blackwell & Co., Ltd.	61,785 12 0

Bolton.—The T.C. has accepted the following tenders in connection with the Electricity Works:—

Messrs. Musgrave & Son, cooling towers.
British Insulated & Helsby Cables, Ltd., cables for one year.
Mr. R. W. Kenyon, wood casings for one year.

Derby.—The E.L. Committee of the T.C. has accepted the following tenders:—

St. Helens Cable Co., Ltd., Warrington, feeder cables, £861, and distributing bitumen cable, £439.
Messrs. S. R. Turner & Co., Ltd., lathe and pillar drilling machine.
Messrs. C. A. Parsons & Co., Ltd., steam turbine, £3,950.
British Thomson-Houston Co., Ltd., switchboard extension, £287.

Eccles.—The T.C. has accepted the tender of the Langdon-Davies Motor Co., Ltd., for the supply of standard motors for hiring-out purposes during the ensuing year.

Glasgow.—The Sub-Committee on Stores of the Tramways Committee of the T.C. have recommended for acceptance the following among other offers:—

India-rubber gloves, India-Rubber, Gutta-Percha & Telegraph Works Co.
Points, &c., for permanent way, Hadfield's Steel Foundry Co., Ltd.

The Clyde Navigation Trustees have remitted the tenders for the generating plant, for the Electric Power Station at Clydebank Dock, to their electrical engineer for report, after which the tenders will come before the Works Committee, who have been instructed to accept the lowest satisfactory tender.

Halifax.—The Electricity Committee has accepted the tender of the Electric Construction Co., Ltd., for a balancer and switchboard, at £355.

Keighley.—The Electricity Committee of the T.C. has accepted the tender of the Phœnix Dynamo Co., Ltd., of Bradford, for the supply of a 300-KW. engine and dynamo (engine by Messrs. Browett, Lindley & Co.), at £1,420.

London.—The Metropolitan Asylums Board on Saturday accepted the tender of Messrs. J. W. Gray & Son, for the installation of a system of electric fire alarms and telephones at the Gore Farm (Upper) Hospital (£670). Five out of six selected firms tendered. The tenders submitted were as follows:—

J. W. Gray & Son (accepted)	£670
Private Wire & Telephone Installation Co., Ltd.	691
Julius Sax & Co., Ltd.	744
New System Private Telephone Co., Ltd.	775
Wenham & Waters, Ltd.	889

The estimate of the engineer-in-chief was £600.

FORTHCOMING EVENTS.

Monday, May 8th.—At 5 p.m. Royal Institution. Annual General Meeting.
I.M.E. (Graduates). Mr. A. B. Scorer, on "Design and Construction of Horizontal Engines."
Tuesday, May 9th.—At 8 p.m. I.E.E. (Glasgow). Annual General Meeting. Paper by Mr. P. D. Ionides, on "A.C. Motors in Industrial Service."
Wednesday, May 10th.—At 7.30 p.m. I.E.E. (Birmingham). Annual General Meeting.
At 7.30 p.m. Association of Engineers-in-Charge. Annual Meeting.
Thursday, May 11th.—At 5 p.m. Royal Institution. Prof. Sir James Dewar, on "Flame" (Lecture II.).
At 8 p.m. I.E.E. at Society of Arts. Mr. H. Laws Webb, on "Telephone Traffic."
Friday, May 12th.—At 9 p.m. Royal Institution. Prof. Ernest F. Nichols, of Columbia University, N.Y., on "The Pressure Due to Radiation."
At 8 p.m. Physical Society. (1) "A Simple Method of Determining the Radiation Constant: Suitable for Laboratory Experiment," by Dr. A. D. Denning. (2) "A Bolometer for the Absolute Measurement of Radiation," by Prof. H. L. Callendar. (3) "The Resistance of a Conductor the Measure of the Current Flowing Through it," by Mr. W. A. Price.
Saturday, May 13th.—Junior Institution of Engineers. Visit to the Dorking Water, Gas and Electricity Works. Train leaves Cannon Street at 1.30 p.m.

THE ELECTRICAL ENGINEERS R.E. (VOLS.).

The following orders have been issued for next week:—

Monday, May 8th.—"A" Company. Drill Order Parade at 7 p.m. Technical Instruction, 8 p.m.
Tuesday, May 9th.—"B" Company. Instructional Drill, 7 p.m. Technical Instruction, 8 p.m. Medical Inspection for Recruits and Special Service Section, 7 p.m.
Wednesday, May 10th.—Adjutant's Drill at Millbank Barracks. Parade at Headquarters, 7 p.m. Drill order.
Thursday, May 11th.—"C" Company. Technical Instruction, 6 p.m. Company Drill, Parade at Headquarters, 7.45 p.m. Rifles and side arms. Plain clothes.
Friday, May 12th.—"D" Company. Recruits' Drill, 6 p.m. Drill Order Parade for whole of Company, 7 p.m. Technical Instruction afterwards.
Saturday, May 13th.—Route March. Parade at Headquarters, 4.30 p.m., *vide* May Regimental Orders.

Wilfrid C. Dumble, Captain R.E.
For O.C.E.E.R.E. (V.)

NOTES.

Superheating and Engine Economy.—In his articles on superheating in the *Engineering Magazine*, Mr. R. M. Neilson states what appear to be correct views as to the effects of superheat and the reasons for its economy. He realises that it diminishes that exchange of heat which has proved so detrimental to economy in all steam engines. Leakage occurs mainly in the form of water, and since steam does not leak much as steam, both cylinder condensation and leakage are cured by superheating. Mr. Neilson realises also that the increased efficiency of the steam turbine with superheated steam is due chiefly to the avoidance of fluid friction. With this we can agree. It is claimed by some that superheated steam is economical because it occupies a larger volume, weight for weight, than cooler steam. This is an error that Mr. Neilson seems disposed to counter, but he is not very strong in his denial of the fallacy. Superheated steam contains a maximum of heat per pound, but saturated steam contains more heat per unit volume, and though there may be slight thermodynamic gain with superheat, this can only be secured when superheat extends to and beyond the cut off point. Mr. Neilson, however, points out that the expansion curve of superheated steam has a rapid drop. He advocates compound engines for superheated steam, with an intermediate reheater. Two-stage superheating has certainly a practical excuse for its existence, for the engine may not be of a type to work well with superheat so high in the first cylinder as will ensure any of it remaining to the second cylinder. As regard superheated jackets, they are advised for the first cylinder of a compound engine if the engine will not bear sufficient temperature of steam alone, but the jacketing of the second cylinder has, it is said, no excuse.

An example of a reheater is shown in which overheated steam travelling to the first cylinder is toned down by meeting the exhaust of the first cylinder. This practice is open to certain objections, and it would seem to be sounder practice simply to heat the first cylinder steam to the required temperature and to use separate steam through the reheater back to the boiler. From figures collected by the author a table is made up showing the results of a number of tests made here and elsewhere in Europe and America with superheat varying from 13 to 440°. The greatest economy appears with a superheat of 225°. It is 36·4 per cent. or 0·17 per cent. per degree of superheat. The figures are for economy in steam, not fuel.

We quite fail to follow Mr. Neilson when he says that in most cases where a flue-fired superheater is employed, the waste gases cannot afterwards be used to heat a feed-heater. He modifies this statement to some degree in a following paragraph, but we think he does so with the idea in his mind of endeavouring to do too much with a boiler. As regards the life of superheaters, the author can tell us nothing very definite, though he admits that a well-designed superheater should last as long as a boiler. He does not, however, furnish any guide to what may be considered a well-designed superheater. The only rational way of controlling superheat temperature is to use heavy tubes so that the metal will not quickly acquire the temperature of the gas, and to employ a system of heated water control pipes. Both these means imply considerably enhanced first cost, but they will add indefinitely to the life of the superheater, and will enable a higher mean temperature of superheat to be secured without exceeding a safe minimum, whilst also safeguarding the engine from disaster.

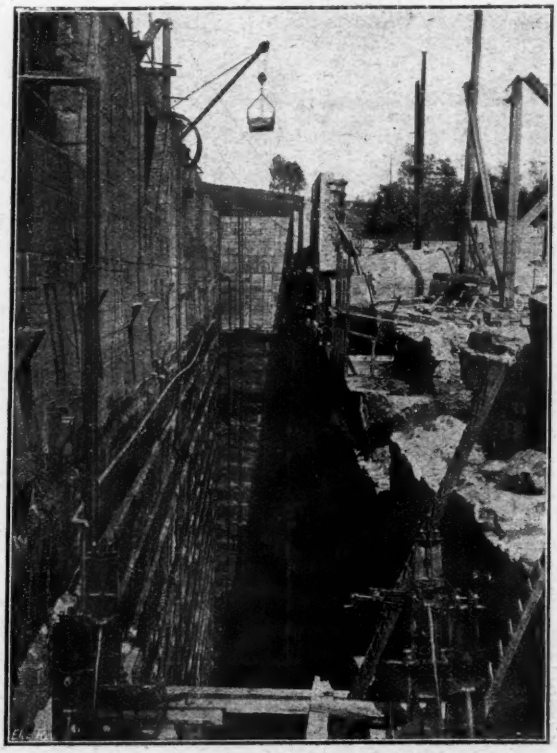
The author, in discussing steam pipes, states that the same pipe will convey at least as much power, measured at the engine, with the same loss of pressure when passing superheated as when passing saturated steam; though the former may have the greater bulk, the friction is less, and the engine uses less. We should say generally that this statement errs on the side of moderation.

The author expresses no opinion as to the best degree of superheat. On this point it may be said that at present a temperature of 500° F. at the engine seems enough. We would not say that a greater temperature is not possible, or even easily practicable, but, as in all practical work, the extremes of the curves of performance that may be plotted out, will often be more than counter-balanced by other opposing factors. It is the first hundred degrees of superheat that tells: the economy increases at a constantly decreasing rate, and it is never worth while to attempt to extract the last fraction possible.

The Canadian Niagara Falls Development.—On Saturday last Lord Grey, the Governor-General of Canada, inspected the work of the Electrical Development Co. of Ontario. This company is to develop 25,000 H.P. for transmission to Toronto, Hamilton, and the principal towns and cities of Ontario within a radius of 100 miles of Niagara.

Our correspondent at Niagara, Mr. Orrin E. Dunlap, writes:—

"The nineteenth annual report of the Commissioners of Victoria Park, on the Canadian side at Niagara Falls, is an interesting document in its relation to the development of electrical power. It is in Victoria Park that the greatest electrical development in the world is now in progress, and it is clear from what the Commissioners say that there is money in the development for the Province of Ontario, if not as yet for the three great companies that have there undertaken the development of the power of the Horseshoe Fall. According to the report the Canadian Niagara Power Co. up to December



Wheel-pit for power station of 125,000 H.P., 416 ft. long × 144 ft. deep; Main tailrace tunnel, 1,935 ft. long × 26 ft. high; Subsidiary tailrace tunnels, 550 ft. long; Power station 500 ft. long, containing eleven generators of 12,500 H.P. each.

Electrical Development Co., of Ontario, Ltd.

31st, 1904, had paid the Commissioners the sum of $224,577·78 for its rights, and up to this time it had only 30,000 developed H.P. The Ontario Power Co. had paid the Commissioners $110,000, and it will be some months ere it has a single horse-power developed in its station. The Electrical Development Co., of Ontario, Ltd., has paid $30,000, and it also will be some months before it will have any power for sale. Combined, these sums make $364,577.78. But the Commissioners have other sources of revenue, the photographic and other privileges having paid in $103,700, while the electric railway through the park between the Falls and Queenston has contributed $132,500. The grand total of these amounts is $620,777.78, which certainly must be considered a very respectable sum to be developed by a free park. The report states that the annual revenue now assured to the park from the various franchises is $84,200, which, owing to the

demand for electrical energy, is very likely to be increased to over $200,000 annually within the next five years.

"On the question of future franchises and the future development of power, the Commissioners have this to say:—'Seeing that three franchises have already been granted for the withdrawal of water from the Niagara River for the development of approximately 375,000 E.H.P., and a further franchise for 100,000 H.P., to be drawn from the Chippawa River, making an aggregate development already authorised of possibly 475,000 H.P., it rests with the Government to decide whether, as a matter of public policy, any further concessions shall be granted at the present time.' The points to be considered are then enumerated."

Electric Railway Prize Competition.—The prize competition opened by the Berlin Technical High School for 1905-6 relates to the submission of schemes for the solution of the problem of introducing electric traction on the Berlin metropolitan railway. One of the projects already sent in emanates from the department for mechanical engineering. It submits that by conversion to electric traction the speed on the railway could be increased to about 20 miles an hour if an average speed of 23½ miles an hour were maintained between the stations, and the average duration of the stoppages did not exceed 20 seconds. By this means the complete journey would be accomplished in 21 minutes, instead of 31 minutes, as at the present time. The scheme proposes that the trains should be composed of motor-cars and trailers similar to those used on the line between Grosslichterfeld-Ost and the Potsdam circle railway station, and that the maximum speed capable of being attained should range from 31 to 37 miles an hour. The trains in normal service are to be formed of two motor-cars and two trailers, while on days of heavy traffic and on Sundays, eight cars would constitute a train. The scheme suggests the employment of an overhead conductor with alternating current at 6,000 volts and return by the track rails.

Incorporated Municipal Electrical Association.—A circular has been issued by this Association to central station assistants in municipal employ as follows:—"It is felt that Associate Members and Associates are at some disadvantage as compared with Members in regard to attendance at the annual convention, it being impossible for an assistant to be absent at the same time as his chief. The Council being desirous of removing this difficulty and of enlarging the scope of the Association, has under consideration a scheme for holding either a second convention, or quarterly provincial meetings each year, specially for those who are at present prevented from attending the annual gathering. Before, however, coming to any decision in the matter, the Council is desirous of ascertaining the opinions of those concerned, and particularly as to what extent they will support it, and therefore asks that the attached form may be filled in and returned to the secretary as soon as possible. Whether the scheme can be carried to a successful issue or not will depend almost entirely upon what proportion of those now eligible for associate-membership or associateship make application to join, in view of the proposed extension of the scope of the Association. The matter is therefore practically in the hands of those in whose interests the scheme is promulgated." The form sets out a number of questions asking whether the recipients are prepared to support the movement, and to pledge themselves to attend the meetings, and where the additional conventions should be held.

Cheap Power in Canada.—In a letter to the *Times*, Mr. J. G. Colmer says: "The question of cheap power is attracting much attention all over Canada, and the utilisation of the numerous water powers to be found in every province, for the generation of electrical power at a moderate price, is bound to give an enormous impetus to the development of the manufacturing and other industries of the Dominion and of local transportation facilities within the next few years."

Spectrum of the Electric Arc.—MM. de Kowalski and Joye (*Comptes Rendus*, April 17th) find that the spectrum of the electric arc near the cathode shows the presence of metallic vapours, due to its high temperature.

Accident at Rochdale.—On Wednesday a serious explosion occurred in Drake Street, Rochdale, by which an electrician named Daniel Lawton, of 4, Nelson Street, was badly injured. He proceeded to the sectional electric supply box in Drake Street to do some repairs; on opening the door of the box, there was a loud report, and a flame burst forth. Lawton was struck on the face, and hurled with great force into the middle of the road. Serious injuries to his head necessitated his removal to the infirmary. He was also badly burnt about the face.

Appointments Vacant.—Johannesburg Council is inviting applications for the positions of general manager of the tramway, lighting and power undertakings (£2,000), and of station engineer (£1,000); a clerk is required at Wrexham Electricity Works; improver for Coventry Electricity Works (£50). See our "Official Notices" to-day.

Bogus Claim.—Sentence.—At the Mansion House on Monday, John Smith was sentenced to six months' imprisonment for attempting to obtain £13 by false pretences from Messrs. Dick, Kerr & Co., Ltd., who are constructing the tramways between Edmonton and Tottenham. Prisoner alleged that an accident had occurred to his pony and cart, but the story was found to be untrue. Prisoner had already received two sums of £14 and one of £15 from the Ocean Accident and Guarantee Corporation in respect of other claims. He lives in the same house as is occupied by a number of other persons who had made claims.

Institution Notes.—ROYAL INSTITUTION.—The annual meeting of members was held on Monday afternoon, the Duke of Northumberland, K.G., president, in the chair. The annual report for the year 1904, showed that 71 new members were elected; and 63 lectures and 19 evening discourses were delivered. The following gentlemen were unanimously elected as officers for the ensuing year:—

President—The Duke of Northumberland.
Treasurer—Sir James Crichton-Browne.
Secretary—Sir William Crookes.
Managers—Sir William de W. Abney, the Rt. Hon. Lord Alverstone, Henry E. Armstrong, Esq., Shelford Bidwell, Esq., Sir Alexander Binnie, the Hon. Sir Henry Burton Buckley, the Right Hon. Charles Scott Dickson, Francis Elgar, Esq., Maures Horner, Esq., Dr. Ludwig Mond, Sir Andrew Noble, Bart., the Rt. Hon. the Earl of Rosse, Sir Thomas Henry Sanderson, Alexander Siemens, Esq., and Silvanus P. Thompson, Esq.
Visitors—Dr. William Arthur Brailey, Dr. John Mitchell Bruce, Sir John George Craggs, Dr. James Mackenzie Davidson, Francis Fox, Esq., Robert Kaye Gray, Esq., Lord Greenock, Charles Edward Groves, Esq., A. Kirkman Loyd, Esq., M.P., Sir Philip Magnus, Carl E. Melchers, Esq., Emile R. Merton, Esq., George Johnstone Stoney, Esq., John Jewell Vezey, Esq., and George Philip Willoughby, Esq.

OUR PERSONAL COLUMN.

[The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.]*

Central Station Engineers.—At a meeting of the Swindon T.C., held on April 17th, it was resolved that the post of shift engineer at the power station be abolished, and that the present shift engineer, Mr. F. V. JORDAN, be appointed station engineer at a salary of £104 per annum.

Since the resignation of the Waipori Falls Electric Power Co.'s chief electrical engineer, Mr. E. E. STARK, Mr. WILLIAMS, the engineer-in-charge, has been carrying on the works. In view of his increased responsibility, and the satisfactory progress made in the laying down of the plant, the Dunedin T.C., which has now taken over the project, has increased his salary.

Mr. W. R. WRIGHT, electrical engineer to the Wellington Corporation, booked a passage for London by the ss. *Corinthic*, which was to leave Wellington on April 27th last.

The Derby E.L. Committee has recommended the T.C. to increase the salary of Mr. T. P. WILMSHURST, electrical engineer, from £500 to £550 per annum, with a further increase of £50 next year.

Mr. W. A. CHAMEN, late chief lighting engineer to the Corporation of Glasgow, was entertained to a complimentary dinner at the Grosvenor Restaurant, Glasgow, on Thursday evening last week.

The employés of the Hove Electricity Works had a "Go-as-you-please" race last Saturday instead of their usual "Walk." The distance covered was 16½ miles. Mr. H. HARPER took the prize as first man home, he having finished in 2 hours 9 minutes 50 seconds, 8 minutes in advance of the next arrival.

Tramway Officials.—Mr. DALRYMPLE, manager of the Glasgow Corporation Tramways, leaves Liverpool by the *Campania* on May 20th for New York *en route* to Chicago, where he is to give the benefit of his professional knowledge towards the municipalising of the tramway system of that city. Mr. Dalrymple will spend a month in Chicago, where he will be the guest of Mayor Dunne, on whose invitation he was granted leave of absence by the T.C. of Glasgow.

General.—The New York *Electrical Review* says that Prof. WILHELM OSTWALD, of the University of Leipsic, has been invited by Harvard University to serve as lecturer during the first half of the coming academic year. This is under the arrangement for an exchange of professors which has recently been agreed upon by Harvard University and the German Government.

Mr. P. BAKER, superintendent of maintenance, Glasgow Corporation Telephone Department, has been granted an increase of salary, raising it to £156 per annum.

Mr. PATRICK G. O'HARA, A.M.I.E.E., having successfully completed his work in connection with the Kolar Gold Fields Electricity Supply, Mysore State, Southern India, arrived in London on board the R.M.S. P. and O. *Persia* on Saturday, April 22nd.

Mr. ARNOLD B. GRIDLEY, having accepted an important position on the staff of the Newcastle-upon-Tyne Electric Supply Co., Ltd., has severed his connection with the B.E.T. Co., Ltd., with whom he has been for the past four years as secretary of some of its associated electric supply and traction companies. On Friday last Mr. Gridley was presented with a canteen of plate and cutlery by some of the directors and staff. The presentation was made by Mr. Garcke, the managing director of the B.E.T. Co.

Mr. PHYA SAKDISENIE has been appointed Director-Général of Posts and Telegraphs of Siam.

A quiet wedding was recently solemnised at St. Mary's Church, Johannesburg, when Mr. ALFRED SIMS, electrician of the Ferreira Mine, was married to Miss Elizabeth Gersden, of Australia.

The *Times* says that Mr. MARCONI is to visit Clifton, Bristol, on his return from America, to unveil the tablet which the Clifton Improvement Committee are about to affix on No. 3, Rodney Place, for some time the residence of Sir Humphry Davy.

Obituary.—The death is announced of Mr. JOHN SPENCER of the firm of John Spencer & Sons, steel-makers, Newburn-on Tyne.

NEW COMPANIES REGISTERED.

British Electrical Device Co., Ltd. (84,321).—This company was registered on April 19th, with a capital of £500 in £1 shares, to carry on the business of manufacturers of and dealers in electrical, hydraulic, pneumatic and steam engines, dynamos, switchboards, switches, pumps, motors, boilers, batteries, cables, wires, telegraph and telephone instruments, &c. The first subscribers (each with one share) are:—W. B. Hardy, 64, Victoria Street, S.W., gentleman; P. J. Bircher, 64, Victoria Street, S.W., electrical engineer; E. M. Harwar, 5, York Buildings, Adelphi, W.C., journalist; P. Collins, 61, Kilmorie Road, Forest Hill, S.E., publisher; J. S. Rowlatt, 89, Highgate Road, N.W., clerk; E. A. Sanderson, 38, Fordel Road, Catford, S.E., accountant; and W. Webb, 22, Cathcart Hill, N., clerk. No initial public issue. Registered without articles of association.

Security Elevator Safety Co., Ltd. (84,363).—This company was registered on April 20th, with a capital of £10,000 in £1 shares, to carry on in the United Kingdom or elsewhere the business of manufacturers and instructors of and dealers in apparatus, machinery and appliances of all kinds fixed in connection with elevators, lifts, hoists or hoisting or lowering machinery, whether worked by hand, mechanical, hydraulic or electric power, hydraulic, electrical, mechanical, and general engineers and contractors, electricians, suppliers of electricity, &c. The first subscribers (each with one share) are:—H. W. James, 106, Pepys Road, Brockley, S.E., accountant; H. J. Bellow, 343, Bensham Lane, Thornton Heath, electrician; H. C. Gray, 8, Wardo Avenue, Fulham, book-keeper; E. Earby, 9, Elmington Road, Camberwell, clerk; H. Balcher, 19, Tintagel Crescent, East Dulwich, cashier; H. J. Holloway, 26, Porchester Road, W., stenographer; and G. H. Wilson, 12, Macroom Road, Paddington, stenographer. No initial public issue. The number of directors is not to be less than two nor more than five; the first are W. D. Baldwin, C. Clarke, J. Cruickshank, D. W. R. Green, and R. H. Thorpe; qualification, £100; remuneration as fixed by the company.

United Electrical Construction Syndicate, Ltd. (84,369).—This company was registered on April 20th, with a capital of £10,000 in £1 shares, to establish companies and associations for the prosecution or execution of electrical and other undertakings, works and enterprises in the United Kingdom or elsewhere, and to carry on the business of electricians, electrical engineers, founders, india-rubber manufacturers, company promoters, financiers, &c. The first subcribers (each with one share) are:—J. E. Percival, 59, Elms Road, Clapham Common, S.W., accountant; G. W. Drake, "Ashleigh," Bush Hill Park, Middlesex, articled clerk; G. W. H. Pidcock, 74, Fitzjohns Avenue, Hampstead, N.W., articled clerk; F. W. Barnes, 127, Capworth Street, Leyton, clerk; A. Champion, 36, Lucas Road, Penge, clerk; G. Cruickshank, 120, Ivydale Road, Nunhead, S.E., clerk; and G. E. T. Stebbing, 130, Narborne Avenue, Clapham Park, S.W., law clerk. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, two shares; remuneration, £500 per annum, divisible.

Projects, Ltd. (84,414).—This company was registered on April 28th, with a capital of £2,000 in £1 shares, to apply for provisional orders or bills for the construction of light railways and other railway or tramway projects, electric light generating and power stations, telegraphs, telephones, or other means of communication, to develop and turn to account the same, and to carry on the business of contractors, landowners, bankers, capitalists, financiers, concessionaires, carriers, suppliers of electricity, engineers, &c. The first subscribers (each with one share) are:—T. Scott, 3, London, Wall Buildings, E.C., engineer; R. H. Pearson, 20, Moorgate Street, E.C., engineer; P. H. Russell, Tramore, Bishopsthorpe Road, Sydenham, S.E., gentleman; H. L. Godden, 20, Moorgate Street, E.C., civil engineer; T. C. Ashcroft, 73, Cheapside, E.C., clerk; W. F. Porter, 74, Cheapside, E.C., clerk; and R. Grimwood, 74, Cheapside, E.C., clerk. No initial public issue. Registered without articles of association.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Hove Electric Lighting Co., Ltd. (36,142).—This company's annual return was filed on April 5th, when 15,000 shares had been taken up out of a nominal capital of £100,000 in 20,000 shares of £5 each; £5 per share has been called up on 13,000 and £3 per share on 2,000 shares, and £71,382 has been received, including £882 paid in advance of calls. Mortgages and charges, £44,600.

Mann, Egerton & Co., Ltd., electricians, Norwich, Lowestoft and Ipswich (83,780).—A trust deed, dated April 1st, 1905, to secure £10,000 debentures, has been registered. Property charged: Freehold and leasehold properties in Norwich, Ipswich, and the company's undertaking and property, present and future, including uncalled capital. Trustees: G. F. Buxton, J.P., Dunstall Hall, Norfolk; and J. J. D. Paul, Eaton Grove, Norwich. Issue, on April 1st, of £2,500, and, on April 3rd, of £1,000 debentures, part of abovementioned series, charged on the same property. Trustees: As above.

Cambridge Electric Supply Co., Ltd. (36,457).—A memorandum of satisfaction in full of a debenture or charge, dated January 1st, 1904, securing not more than £20,000, has been filed.

Howard Conduit Co., Ltd. (69,270).—This company's annual return was filed on April 13th, when 1,007 ordinary and 1,000 deferred shares had been taken up out of a nominal capital of £20,000 in 19,000 ordinary and 1,000 deferred shares of £1 each. £1 per share has been called up and paid on 7 shares, and the remaining 2,000 are considered as fully paid. No mortgages or charges.

Chelsea Electricity Supply Co., Ltd. (20,468).—This company's annual return was filed on April 3rd, when 44,436 ordinary, 6,000 preference, and 500 founders' shares had been taken up out of a nominal capital of £400,500 in 74,000 ordinary and 6,000 preference shares of £5 each, and 500 founders' shares of £1 each. £5 per share has been called up on 37,770 ordinary and 6,000 preference, and £218,850 has been received. £33,830 is considered as paid on 6,666 ordinary and 500 founders' shares. Mortgages and charges: £175,000 debenture stock and £800 "buildings."

Charing Cross, West End and City Electricity Supply Co., Ltd. (29,122).—This company's annual return was filed on March 27th, when 80,000 preference, 80,000 ordinary, 80,000 "City Undertaking" preference, and 70,000 "City Undertaking" ordinary shares had been taken up out of a nominal capital of £2,100,000 in 130,000 preference, 130,000 ordinary, 80,000 "City Undertaking" preference, and 80,000 "City Undertaking" ordinary shares of £5 each. £5 per share has been called up on 80,000 preference, 80,000 ordinary, and 80,000 "City Undertaking" preference shares, and £1,200,000 has been received. 70,000 "City Undertaking" ordinary are considered as fully paid. Mortgages and charges: £400,000 4 per cent. debenture stock and £400,000 5 per cent. "City Undertaking" bonds.

C. & A. Musker (1901), Ltd., electrical and general engineers, Liverpool (70,578).—A memorandum of satisfaction in full of debentures, dated July 9th, 1901, securing £20,000, has been filed.

Wycombe (Borough) Electric Light and Power Co., Ltd. (53,133).—Particulars of a series of debentures, created by resolutions of April 6th, 1899, April 21st, 1902, and April 8th, 1904, securing an amount not exceeding the company's subscribed capital for the time being, and having the benefit of a trust deed, dated April 16th, 1902 (supplemental to a trust deed dated April 27th, 1899), have been filed pursuant to Sec. 14 (4) of the Companies' Act, 1900. Property charged: The lands, buildings, machinery, works, plant, effects, undertaking and property of the company, including uncalled capital. Trustees: W. B. Hopkins, Club House, Surrey Street, W.C.; and F. E. Gripper, Broad Sanctury Chambers, Westminster.

Electrolytic Alkali Co., Ltd., Middlewich (64,360).—Issue, on April 18th, of £3,150 debentures, part of series created July 9th, 1904, to secure £50,000, charged on the company's undertaking and property, including uncalled capital. Trustees: Liverpool Mortgage Insurance Co., Ltd., 6, Castle Street, Liverpool. Previously issued of same series: £17,500.

Ackroyd & Best, Ltd., lamp manufacturers, Morley (54,600).—Issue, on April 5th, of £1,550 debentures, part of series created March 3rd, 1904 to secure £15,000, charged on the company's undertaking and property, present and future, including uncalled capital. Trustees: C. T. Naylor, Dean House, Kilmeston, Alresford, Hants; and J. L. Humble, Treelands, Birkenshaw. Previously issued of same series: £4,850.

South Metropolitan Electric Light and Power Co., Ltd. (47,875).—Issue, on April 18th, of £15,000 debentures, part of series created July 3rd, 1900, and May 16th, 1904, to secure not more than the paid up capital for the time being. Property charged: The company's undertaking and property, present and future, including uncalled capital. The debentures are issued to the trustees as further security for debenture stock covered by trust deeds of August 3rd, 1900, and June 3rd, 1904. Trustees: H. R. Beeton, 18, Austin Friars, E.C.; and W. R. Davies, 10, Moorgate Street, E.C. Previously issued of same series: £173,292.

Eastern Telegraph Co., Ltd. (6,338).—A mortgage or charge, dated April 5th, 1905, to secure £10,000 debenture stock, ranking *pari passu* with previous issues amounting to £1,897,704, has been registered. Property charged: The company's undertaking and revenue. Holder: F. R. de Levanté, 141, Hill Street, Peckham, S.E.

CITY NOTES.

Johnson-Lundell Electric Traction Co., Ltd.

We gather from the financial Press that a meeting of the shareholders of the above was held last Friday at the company's new works in Southall. A copy of the report of the directors has also been published, from which it appears that the company is now, for the first time in its existence, in possession of works of its own. These works, it is true, are on a very moderate scale for a company having an authorised capital of £300,000, the total outlay on the factory, including erection, equipment and cost of freehold ground amounting to less than £10,000, of which the cost of the ground alone was £1,000.

When the company was first formed, we commented favourably on its prospects, and, had it been properly managed, it would at the present time be in a better position than it is. We must, however, point out that, at the time of our first notice, we were credibly informed that the company had practically sold the Foreign patents for almost as much as was paid for them to the vendors. Whether we were misinformed, or whether the negotiations have fallen through owing to unforeseen circumstances, we do not know, but the fact remains that the Foreign patents have not yet been sold, and there is very little, indeed, to show for the four years during which the company has been in existence.

The chief properties of the original company were the Lundell split-pole dynamo, from which very great things were expected, a system of regenerative control which appeared to possess novel features, and also a surface contact system, and other items to which no one attached much importance. The split-pole dynamo has been successful, we believe, in those places in which it has been installed, and was at the time of the formation of the company a marked step in advance of anything that had been previously done. There are, of course, other sparkless dynamos on the market now, and unless the Johnson-Lundell machine can be produced at a cheaper cost than its rivals the patents have very little, if any, value at all. Probably if the company had been able to manufacture its own dynamos instead of being dependent upon one firm to which the sole licence was granted, and whose works were not at the time equipped for the manufacture of large machines, things might have gone differently.

As regards the regenerative system of control, this it appears was in a very nebulous condition at the time the patents were sold, and a very considerable amount of money has been expended in experimenting and perfecting the details. This expense, it seems to us, should be borne by the vendors. We gather from the report that the system is now ready to be put on the market on commercial lines. We are given to understand that on the Johnson-Lundell system there is no need for the driver of a car to handle the brake at all, and that the mere operation of the controller handle starts the cars, slows it down by regenerative action, and finally brings it to rest by automatically applying a mechanical brake. As the brakes are always on when no current is passing to or from the line, it follows

that in the event of the trolley leaving the line, the car would be automatically brought to rest. This is a very valuable feature.

The meeting called last week was principally with the object of agreeing to a proposal made by Messrs. J. H. Holmes & Co., who are part promoters of the scheme. This firm have already lent £10,000 to the company to assist in bringing the traction apparatus to a commercial stage and to preserve the patents. They have now proposed to make a free gift of this £10,000 to the company, and also to assign the whole of their shares and surrender all their rights against the company for the benefit of those shareholders who took up capital of the company owing to their connection with it. The face value of the shares held by them amounts to almost £45,000.

There has been a proposal on the part of some of the shareholders to take action against the promoters in order to recover their money, on the ground of misrepresentation. We gather from the report that the present directors have taken counsel's opinion on the matter, and are advised that proceedings could not be successfully maintained against the promoters.

For our own part we feel sure that Messrs. J. H. Holmes & Co. are as disappointed as anyone at the non-success of the company, and that any suggestion of misrepresentation or fraud on their part would be quite unjustified.

This agitation, however, against the promoters has been largely engineered by a person calling himself L. Williams, who has apparently travelled the length and breadth of the country interviewing shareholders, promising and practically guaranteeing success if the matter were put in his hands.

We understand that at the recent meeting, the shareholders present unanimously decided to accept Messrs. J. H. Holmes & Co.'s offer, which was the best thing they could do under the circumstances, and whilst we think it quite impossible that the company can ever pay any dividends on such a capital as they are now saddled with, yet we feel sure that the present directors, with such a keen business man as Mr. Mackay at their head, will leave no stone unturned to put the company on as satisfactory a basis as is possible.

Kalgoorlie Electric Power and Lighting Corporation.

THE meeting of this company was held on Wednesday at Winchester House, Mr. Roger W. Wallace, K.C., in the chair.

In proposing the adoption of the report, the CHAIRMAN said that the balance of the trading account from Western Australia was £18,334 11s. 5d., as against £9,336 9d. last year, so that they had doubled their net receipts from Australia during the course of the past year. With regard to what was included in that, of course all the expenses of management had been already taken off on the other side, and they also included auditors' fees in Western Australia, and every expense of operating there, the £9,336 being the net revenue. He considered that was a very satisfactory result in the early stages of the company and it was a great deal due to the work of their manager, Mr. Crocker. He had done his work very well. He had no local board to supervise him—they had to do that work on this side. Considering he was so far from those who instructed him, he must say that everything had been done by Mr. Crocker in the best possible manner, and it was a source of great encouragement to them, after their experience of their management and their local board in Australia, that the work was done so much better now than it was in past times. Turning to the accounts, the item of £985 for directors' fees was a reduction of £344 upon that which they were entitled to charge. The directors had been of very considerable assistance to him in the management of the company, and during the past year there had been a very great deal of extra work owing to the negotiation of contracts, and to disputes which had arisen with their consumers, which had been dealt with on this side. It had been proposed that they should increase the board, as one of their number, Mr. Wyman, whom they very sorry to lose, had retired. He (the chairman) had proposed that Mr. Ritchie, who was formerly a director, should be elected to that position, as he thought he was entitled to it. Mr. Ritchie, however, living as he did in the country, did not wish to occupy the position, and had forwarded another name. However, when the board considered the matter they came to the conclusion that it was not advisable to appoint another director, but to go on as they were. They had written off finally the cost of issue of debentures, £344. They had also written off the whole of the balance of the preliminary expenses, £5,486. It would be remembered that the debentures were issued on the understanding that if they were redeemed they should be redeemed at 102. They had thought it would be wise to write off that 2 per cent., and to provide for it so that the debentures would stand at par when they came to be redeemed. They had, therefore, provided £660 for that purpose. They had put £6,750 to reserve, for although the plant was kept up to the full in Australia, and all renewals were paid for, they thought it was desirable to have a fund for depreciation, and for more extensive renewals should they be necessary. Some of the shareholders might say that the board had been a little too drastic in some of those matters, but before they could get into a position to declare dividends, they thought it was desirable that they should place their accounts on a thoroughly sound basis, and having done that, they were now in a position to declare dividends. They would be able to go on declaring dividends, and in October they would declare a dividend for the past six months, leaving the arrears to be dealt with in some other way. They would go on declaring dividends every half-year, and they would deal with arrears either by paying off so much per annum, or by the issue of certificates. They had made some excellent contracts with the consumers during the past few months, and they had settled some rather difficult disputes in the way of claims that they had against some of the companies for not taking the current they required. He was also glad to say that that morning he had concluded rather difficult negotiations which he had had to conduct for some time with the tramway company. They had come to an agreement which was satisfactory to both of them. Those negotiations had been very arduous, and the result was this—that they were to have a fair price for the electricity they supplied, and they, in conjunction with the tramway company, would manage the tramway line, so that they could see that the electrical load was properly distributed. That would be a very great benefit to them in their working, as they would get the exact amount required from time to time. They would receive all the receipts and hand back to the tramway company their fair proportion. The agreement gave them the whole of the tramway business for the length of their concession. The effect would be that practically all their load would be taken up, and it would be necessary for them to consider how they should extend their plant in the future.

Mr. EDWARD POPE seconded the motion, which was carried after some discussion.

Rand Central Electric Works, Ltd.

THE annual meeting of this company was held at Winchester House, on Thursday last week, Sir C. Rivers Wilson presiding.

In moving the adoption of the report and accounts, the CHAIRMAN said that the position of the company during the past year had been a satisfactory one. There had been a considerable increase in the revenue, and they had been able finally to liquidate the deficiency which had hung over them like an incubus, and which arose out of the political disturbances. Taking everything into account, he considered that they had a very encouraging outlook for the future. Turning to the accounts, they would notice that there was an item of £2,400 expended on works. That included the cost of new compounds and a recreation hall for their employés. The last was of very considerable interest, for it had for its object the retaining of a staff of satisfied employés. They had about 150 native workmen, and it was very desirable to retain them on their works, and to discourage them as much as possible from going into Johannesburg for their amusements. The item for extension of plant was new. The £6,852 had been allotted to the erection of the new turbo-generator, which was now on its way out. When it was finally *in situ* it would have cost some £12,000 altogether. The sum of £40,700 for mine installations was entirely attributable to the extension of the company's operations. Cash at bankers had been increased since last year by £34,700. From the profit and loss account, they would observe that working expenses, salaries, &c., had been £34,000. With regard to their water supply, he would like to say that they had now made a new arrangement with the syndicate, and, no doubt, when the new Water Board was working they would get their water at an even cheaper rate. As to the royalty to the Transvaal Government, the arrangement had been that they were to pay the Government 2½ per cent. on the net profit earned. They were now in friendly relations with the authorities, and were discussing the matter of depreciation with them. He thought that it was only fair that the amount for depreciation should be deducted before the 2½ per cent. on the profit was calculated. Negotiations were now in progress, and he hoped that the matter would be satisfactorily settled. The amount involved was certainly small—£236 for 1903, and £417 for 1904—but it was the question of principle which was to be considered. While he was dealing with the question of depreciation, he might say that the board had come to the conclusion that it would be better to alter the form in which it appeared in the accounts. It was proposed to accumulate a renewal fund which could be used for making good any deficiency. It would not be a real alteration, but he thought it would be a better method of stating it. On the credit side they would notice that there had been an increased revenue from all sources of £24,359. To sum up the financial position of the company, they had earned a sum of £31,780 net profit, or 10½ per cent. on their capital. They had wiped out a deficit of £12,000, and the sum that remained would pay 5 per cent. to the shareholders, and allow them then to carry forward a sum of £4,500. As regards the future of the company's operations, they had taken steps for supplying a certain amount of extra power. He told them last year that the turbo-generator would be out there in October, but that had been found impossible, and there had been a short delay which they did not anticipate at that time. However, the condensers for the boiler plant had been erected, and the foundations for the turbo-generator put in. It now remained for the turbo-generator to be erected; it was, he believed, either very nearly out there or actually on the coast, and he hoped that by midsummer it would be in operation. Their four existing engines had a total capacity of 2,800 KW., and although it was originally intended that one of those engines should be kept as a reserve, it had been found necessary to trench somewhat upon the

reserve, and sometimes to have the four working together. Their maximum demand had been in June last, when they were called upon to the extent of 2,460 KW. The erection of the turbo-generator would be of very great advantage to them, and he had very little doubt that in time a further extension would be necessary. When that time came, another turbo-generator could be put in at a cost of only £4,000 or £5,000. In conclusion, he referred to the work of the local board, and remarked that it would be satisfactory for that board to know that their efforts were appreciated in London.

Mr. H. STRAKOSCH seconded the motion, which was then carried.

The retiring directors (Mr. G. von Chauvin, and Mr. A. H. Marker) were re-elected on the board, and the auditors (Messrs. Price, Waterhouse & Co.) having also been re-elected, the proceedings terminated with a vote of thanks to the chairman for presiding.

Auckland Electric Tramways Co.

MR. C. G. TEGETMEIER presided at the annual meeting held at Donington House on Friday last. In moving the adoption of the report (see ELECTRICAL REVIEW, April 28th, p. 701) he said that they had not yet had a complete year's working of their system because the last 1½ miles was not available for traffic until August last, and their earning capacity had also been affected by the inadequacy of the power plant and rolling stock to meet requirements. They carried the whole population of Auckland more than 250 times. The chairman referred to an action brought against the company by the original promoter of the concession, claiming payment of a very considerable amount of engineering fees and other alleged services. They entered a defence, but since the closing of the accounts the matter had been settled out of Court. The net profits for the year amounted to £26,275, after payment of debenture interest and all other expenses chargeable to revenue. The proportion of expenses to receipts worked out at 60 per cent., which was slightly higher than in the previous year; but one or two exceptional items of outlay fully accounted for the increase. With the highest scale of wages prevailing in Auckland —the motormen were paid at the rate of 1s. per hour, and the other employés in like proportion—their power and running expenses, which were largely composed of wages, must necessarily be comparatively high; but there could be no doubt that while this high standard of earnings of the working-class community increased their expenses, it accounted in a large measure for the much greater extent to which tramway facilities were availed of per head of the population than in this country. The expenditure on repairs and maintenance had been heavy during the past year. A good deal of it was due, not only to ordinary, but also to extraordinary, repairs, and to various improvements which the conditions of the working of the service proved to be necessary. With every portion of the equipment being worked to the full limit of its capacity, it was inevitable that the cost of maintenance and renewals should be high. An additional cause of the amount being large was that it included an expenditure of about £4,000 in connection with subsidences which occurred in certain parts of the track. The traffic receipts for the first three months of the present year were £3,000 in excess of the receipts for the corresponding period of last year.

Official Announcements re Companies.

UNLESS cause is shown to the contrary, the following are to be struck off the register within three months:—

Benfleet Electric Light and Engineering Co., Ltd.
Burn's Patent Tramcar Lifeguard Syndicate, Ltd.
Canadian, British Columbian and Dawson City Telegraph Co., Ltd.
Cardiff and Penarth District Light Railway Co., Ltd.
Electrical Thawing Syndicate, Ltd.
Electric Fur Machining Co., Ltd.
Metal Electro Amalgamating Syndicate, Ltd.
News and Entertainment Telephone Syndicate, Ltd.
O'Brien-Lennard Electrical Installation Co., Ltd.
Weymouth Electric Light and Power Co., Ltd.

City of Birmingham Tramways Co.

MR. GARCKE presided at the annual meeting held at the Grand Hotel, Birmingham, on 27th ult. In moving the adoption of the report, he said that the net profit earned was £3,000 more than in the previous year, and the company had carried 54 millions of passengers as compared with 50 millions in 1903. The efforts to combine the working of the company's tramways with those of the Birmingham and Midland, Wolverhampton, Dudley and Stourbridge and South Staffordshire systems had been successful, and the whole of these concerns were now worked by a joint committee composed of the directors of all the companies. The result of the first six months' experience of this new working had enabled them to effect economies in expenses to the amount of £4,000. Their relations with the City of Birmingham had been carried on on the lines he foreshadowed a year ago, of placing no difficulties in the way of municipalisation, while not sacrificing any interests of the shareholders to make municipalisation possible. For the purpose of local politics, the company had been most unjustly maligned, but the directors had steadfastly pursued their policy of the best possible service for the public, consistent with reasonable profit for the shareholders, and now that municipalisation had been resolved upon, and there was no possibility of the company's leases being renewed, they were facilitating the desire of the Corporation as much as possible. As the Birmingham tramways extended into districts whose lines the Corporation could not acquire, at all events for many years, an arrangement for mutual running powers had been come to, which would be equitable to all parties. All sides had, in the negotiations, acted in a fairly reasonable and business-like manner, and if they could only keep political dust out of the eyes of the people, all the remaining questions between the Corporation and the company would be settled to the benefit of the public. Motor-omnibuses could not compete with electric or cable cars, or even with steam tramcars, but inasmuch as the company operated many miles by means of horse omnibuses, which were not an ideal form of traction, they were watching with interest the development of petrol-driven cars and running some themselves for the purpose of obtaining accurate data as to their working; but the motor-omnibus was in such an elementary and imperfect state that they were not yet justified in substituting them for the whole of their horse service.

Eastern Extension, Australasia & China Telegraph Co.

THE half-yearly meeting was held on Wednesday at River Plate House, Sir John Wolfe Barry, K.C.B., in the chair.

The CHAIRMAN, in proposing the adoption of the report, said that the gross revenue for the half-year under review amounted, in round figures, to £331,000, against £265,000 for the corresponding period of 1903, showing an increase of £66,000. That was a satisfactory result. The increase was due to the China and Japan traffic having considerably increased since the outbreak of hostilities in the Far East. It was encouraging, however, to find that the local and other traffic had also materially increased during the past half-year. With regard to the expenditure, the working and other expenses amounted to £150,000, against £142,000 for the corresponding period, an increase of £8,000. That was principally due to the increase of the staff in China and elsewhere, and also to the repairing ships having had less work under charter than in the corresponding half-year. Taking the figures for the whole year, the results were as follows:—The gross receipts for 1904 amounted to £631,000, against £530,000 in 1903, showing an increase of £101,000. The ordinary expenditure for 1904 was £291,000, against £280,000 in 1903, or an increase of £11,000. The net profit for the half-year was £166,911, and, after adding to it the credit balance of £110,269, there remained an available balance of £277,181. With regard to the dividend, the usual interim dividend of 2s. 6d. per share was paid during the past half-year, and it was now proposed to declare a dividend of a like amount, making a total dividend of 5s., and, in addition, they proposed to pay a bonus of 4s. per share, making a total dividend of 7 per cent. for the past year. They had also been able during the past year to place £120,000 to the general reserve fund, and to carry forward £21,181. He thought that the shareholders would admit that the result of the year's working had been very satisfactory, and that he was justified in the remark he made last year, when he said that he looked forward to better times than he was able to indicate at that period. Since the close of the half-year under review they had considered it advisable, in order to adjust their capital account, to issue a further £150,000 4 per cent. mortgage debenture stock, making a total issue up to date £742,000. The shareholders had perhaps seen reports in the Press regarding a German-Dutch company which was formed some time ago, and was subsidised by the German and Dutch Governments, to enable them to get in touch with German and Holland possessions in the Far East entirely independent of the British cable. He was glad to say that they had come to a satisfactory working arrangement with that company, by which the interests of the shareholders in the Eastern Extension were safeguarded. With regard to the Pacific Cable conference, although no date had yet been definitely fixed, he understood that the long-deferred meeting might take place this month, when the effect upon the Pacific cable of the agreement entered into by certain Australian States, and other questions arising out of it, would be considered.

The Marquis of TWEEDDALE seconded the motion, and the report was agreed to.

Brush Electrical Engineering Co.

THE directors' report for 1904 says that the profit and loss account shows a gross profit of £71,280. General charges, maintenance, interest on debenture stock, and £6,500 carried to depreciation reserve fund, absorb £43,200, leaving a balance of net profit of £28,080, which the directors recommend should be appropriated as follows:—

To dividend at the rate of 6 per cent. per annum on preference shares for the year ended December 31st, 1904. ..	£18,000
To general reserve fund	7,000
To balance carried forward	3,080
	£28,080

The depreciation reserve fund will then stand at £45,107, and the general reserve fund at £16,450. The sum of £11,508 has been expended on additions to plant and buildings during the year. A considerable proportion of this amount is in respect of a complete plant for rendering wood non-flammable or fire-restisting, for which a considerable demand has arisen for rolling stock and other purposes. The company is engaged upon an important electric supply and tramways undertaking at Bombay, on which the sum of £67,791

had been expended at the end of the year, principally upon account of the construction of the electric supply works. Arrangements are in progress, which it is expected will shortly be completed, for the formation of a separate company to deal with this undertaking, which will secure for the company important contracts. The general reserve account has been reduced during the year by the sum of £11,050, representing the book value of the stock of Universal engines. It is proposed, on the other hand, that the sum of £7,000 shall be added out of the profits for the year, so that this fund will stand at £16,450 as above mentioned. The Universal engines have not been satisfactory in some sizes, and their manufacture having been entirely discontinued, the directors have thought it prudent to write off in full the book value of those remaining on hand. The output from the works shows a considerable increase over that for the previous year, and the volume of orders is well maintained. Competition, however, continues to be severe, and the net profits have consequently not increased in proportion to the turnover. Marked progress has been made during the year at Falcon Works in developing new manufactures, and in improving existing designs. This work has involved considerable expenditure on drawings, patterns, experiments, &c., the whole of which has been charged against revenue. The demand which has arisen for motor-omnibuses has for some time past engaged the attention of the directors. The company has already built examples of these vehicles, embodying features of special merit, and arrangements are now being made whereby the interests of the company will receive suitable attention in connection with this important development.

Brockie-Pell Arc Lamp, Ltd.

Mr. R. W. Maynard presided at the annual meeting held at 60 Worship Street, E.C., on Tuesday. He moved the adoption of the report for the year ending December 31st, 1904. This stated that £496 14s. 8d. had been written off for depreciation in plant, machinery and tools, and a further amount of £147 18s. 3d. expended on new patterns during the year, had been charged to revenue account. This left a debit balance of £1,864 12s. 9d. on profit and loss account, which compared with £2,023 3s. 2d. for the 18 months ending December 31st, 1903. The report continued:—

> Despite this result, which is chiefly due to the continued depression of trade and close competition, the directors consider that the company's business is now in a much more promising condition than it was at this time last year. During the year repeat orders for Brockie-Pell lamps have been received from many of the company's old clients, and the total number of orders exceeds that of any previous year. Enclosed arc lamps, embodying considerable improvements, were placed on the market during the last month of the year, and have met with very gratifying success. In consequence of the introduction of these new lamps, some of the old patents have been allowed to lapse, but all those of any value have been kept up. The circular issued by the board dated May 3rd, 1904, explained the result of the inquiry into the company's affairs made by the committee appointed after the last annual meeting, and the board, as reconstituted, have given the closest attention to the company's work, and effected changes which they feel confident will eventually give beneficial results to the shareholders. Mr. Brockie is giving his attention to important details in manufacture which the board have confidence will materially assist the business, and all the lamps now sent out by the company are issued under his personal supervision. It is with the deepest regret that the directors have to record the death of Mr. W. Nicolson, one of the new directors. After careful consideration, the directors have appointed Mr. G. J. Somerville to fill the vacancy on the board, and feel that in doing so they have secured a gentlemen who, in addition to his being a large shareholder, possesses considerable experience in connection with electric supply companies.

The directors of the new company are now as follows: Messrs. H. W. Maynard, the Hon. R. Brougham, R. Warner and G. J. Somerville.

Sir Dixon Hartland resigned at last year's meeting, and Lord Suffield, the chairman, has since left the board.

The Chairman, in referring to the year's work, said that at the last meeting there was a good deal of feeling manifested, and strong words were uttered, and in consequence the directors made considerable changes. A committee was formed; it made inquiries and issued its report. Two of its members joined the board, and one of them, Mr. Nicolson, died not long ago. They could not have read the report with feelings of exalted delight at their great success. They did not wish to give too rosy a view of the position of the company, but to state it fairly and squarely. The new board found that they were, through various people, led into one or two lamps that did not come up to their anticipations, and a considerable change had been made by Mr. Brockie. At one time he (the speaker) was very much against Mr. Brockie, because, although they thought him a genius among inventors, they thought him extravagant and sanguine. He might have learnt lessons, and they felt that now he was a very great strength to the company as technical adviser. Mr. Brockie had introduced to them the "B. E." enclosed arc lamp, and it was on that lamp that they hung their hopes of future prosperity. Wherever it had gone it had won golden opinions. The time was coming when the competition would be even keener, but that lamp could be, and had been, manufactured at a price fairly satisfactory to the company. Mr. Brockie had in his mind a flame lamp which he (the chairman) thought would be equal to anything on the market. His new "Twin" lamp would be a very remarkable one for street lighting. There were also other things in his fertile brain which would keep them ahead of all other makers in the arc lamp trade. They wanted to see their way to spending more upon advertising, and they would be glad of suggestions as to how best to do it. They had three travellers in London, and agencies in various provincial centres. Their Worship Street premises were one of the great weights burdening them. They had tried to get rid of them, but so far unsuccessfully, as the times had been against that sort of thing. Their sales showed a larger number of orders and the gross profits were about 4 per cent. higher than last year. They wanted to reduce the expenses in every possible way. Mr. Brockie had reduced the expenses of the lamps, and they had considerably reduced the expenses of management. Had they been able to reduce the rent, they would have been in a very different position. With the new lamps before them, with an increasing arc lamp trade in London, and with the price at which the lamps could be manufactured, he could only say, as one of the largest shareholders, that he had a very well-grounded anticipation that there would be a very different state of things after another year's working.

Mr. R. Warner seconded the motion.

Some criticisms were offered by shareholders, among them being a request for particulars of the turnover in lamps, the gross profits, or the percentage of expenses in proportion to the turnover.

Mr. A. Bergtheil followed with remarks to the effect that the company ought to give up manufacturing; if it put the matter out to tender, four out of six tenderers would offer to make the lamp more cheaply than the company could itself do it in a London factory. The firms might lose money on it, but that was not this company's concern. He advocated drastic measures, the problem being one of up-to-date finesse of manufacture—American and Continental methods with up-to-date machinery.

The Chairman having briefly replied to these and other remarks, the report was adopted.

Deutsch-Atlantische Telegraphen Gesellschaft.

The report of this company for 1904 states that the traffic materially increased, particularly in the last four months of the year. The second section of the duplicate cable—that between the Azores and New York—was completed at the beginning of the year by the Norddeutsche Seekabelwerke, of Nordenham, and the entire deep-water section was laid without any incident by the cable steamer *Stephan* in 11 days during May. The new cable works with complete satisfaction. As the company now has two cables at its disposal between Germany and America, it was possible to bring into operation at the Azores an automatic translator for which preparation had for a long time been made. By this means a considerable portion of the traffic since October had been directly transmitted between Emden and New York, which meant an essential saving in time for the whole of the traffic. On October 30th, 1904, a fault occurred in the Borkum—Fayal cable II. (1903), but this was remedied in January, since which time the cable has worked satisfactorily. As mentioned in previous reports, the company was under the obligation to purchase, by December 31st, 1904, at the latest, the Emden—Vigo cable or the shares of the Deutsche See-Telegraphen Gesellschaft. During 1904, negotiations took place with the shareholders in the latter company, with the result that the shares were taken over and the working of the cable transferred to the account of the Deutsch-Atlantische Gesellschaft from January 1st, 1905. The final settlement of the transfer will be completed in the current year. According to agreements with the Imperial Post Office, the company has received, after the completion and opening of the whole length of the duplicate cable, a contribution of £37,500, of which the sum of £20,000 is for partly meeting the interest on the obligations, and £7,500 is intended for the maintenance of the duplicate cable. For the year 1905 the company will receive £81,000, of which £40,000 will be for interest on the bonds and £15,000 for the maintenance of the cable. The Norddeutsche Seekabelwerke, of which the company possesses one-half of the share capital, was fully employed during the past year, firstly on the manufacture and laying of the second section of the duplicate cable, and then on the production of the Guam—Jap—Menado cable for the Deutsch-Niederlandische Telegraphen Gesellschaft. The cable manufacturing company in question has decided to pay a dividend at the rate of 8 per cent. for 1904, and the shares in it held by the Deutsche-Atlantische Gesellschaft are of the nominal value of £150,000. The latter company's share capital of £1,200,000 has now been fully paid by the calling up of the balance of £150,000, which was gradually paid during the year, while the obligation account remains at £1,000,000. After meeting working expenses and interest on bonds, transferring £12,383 to the cable redemption and renewal fund, and deducting £3,967 for depreciation, there remains a surplus of £96,373, as against £78,267 in 1903. A dividend has been declared at the rate of 6 per cent. for 1904, as compared with 5½ per cent. in 1903 on a share capital of £1,050,000, while the remainder of the shares, representing £150,000, will receive 4½ per cent.

Oriental Telephone and Electric Co.

Sir Auckland Colvin, K.C.S.I., presided at the annual meeting held at Great Eastern Hotel, E.C., on Friday last. In moving the adoption of the report (see Electrical Review, April 28th, p. 701), he said that the work of underground cabling at their several stations had already been taken in hand. It was a work that would take perhaps two years—possibly more—to complete, and would involve a good deal of expenditure. It was probable, therefore, that in the near future they might require to issue more capital, and the shareholders would have a first opportunity of subscribing to it; they had not yet decided in what form the issue should be made. Additions had been made to their investments in property. Owing to the difficulties of obtaining sufficiently long leases at reasonable rents, they had deemed it desirable to secure

land, for instance, at Singapore, and to erect a suitable building on that land for exchange premises. This building would be ready for occupation, and for the installation of their new switchboards now on order, before the end of the present year. The Telephone Co. of Egypt—the share capital of which was almost entirely held by this company—continued to do remarkably well. Owing to the calls made upon it by the Government of Egypt for further extensions of the provincial lines, the directors of that company found it necessary to be independent of financial assistance from this company, and created £200,000 of 4½ per cent. debenture stock —£60,000 of which was issued last July—and it was possible, in view of another large order from the Egyptian Government for an extension of these lines, it might have to make a further issue of that stock later on. He (the chairman) had only recently returned from Cairo, where he had been arranging with the Government for a renewal of the lease by Government to that company of the existing trunk lines between Alexandria and Cairo, and also for the erection of two additional circuits to meet the requirements of the public who use these lines very freely for communicating between the telephone systems existing at Alexandria and Cairo. The board had arrived at a decision to establish a sinking fund for the better security of the capital of the company. They were endeavouring to obtain the adhesion of the boards of their subsidiary companies in India to this policy, and if they would make similar provision for the security of the capitals of their respective companies, this company would have so much the less to find annually towards the capitals of their own branches. Their new Indian licenses, as he mentioned two years ago, had a period of 60 years to run from that time. That for Singapore was somewhat shorter, namely, 31 years. The actual sum, therefore, they might have to set aside annually could not yet be financially determined, but they proposed at any rate to make a commencement this year towards establishing a fund such as he had indicated. They further proposed that the amount so set aside should be actually invested in safe securities, and that two members of the board should act as trustees of that fund.

Mr. H. GREWING seconded the motion.

Mr. HIBBERT asked whether it would be possible for the board to give them a balance sheet showing the returns received from all the different companies in which they were interested. He supposed they would not think of amalgamating those companies?

The CHAIRMAN replied that any shareholder by going to the office could see how any of the companies were doing. In regard to amalgamation, they did not think it would be in the interests of the company at all. Not only would it introduce a great many management difficulties, but they found that the present arrangement was more likely to retain the interest of the local community in each place.

The report was adopted, and the dividend resolution approved. The retiring directors and auditors were re-elected.

Globe Telegraph and Trust Co.—A final dividend of 4s. 9d. per share on the ordinary shares is recommended, making a total of 5⅝ per cent. for the year.

North of Scotland Electric Light and Power Co.—The report for 1904 shows that the lamp connections at Montrose have increased from 11,670 to 15,130, and in Brechin from 7,359 to 12,081. The profit for the year, including £470 brought forward, is £2,422, which, after paying interest on loans (£1,695 as against £918 in 1903), leaves £727 available for distribution. A dividend of 2½ per cent. per annum is recommended, carrying forward £433.

West Coast of America Telegraph Co.—The report for the year ended December 31st states that the gross receipts amounted to £42,337, as against £35,708. The working expenses were £28,118, as compared with £28,361. After providing for interest on the debentures and income bonds there remains £7,419, to which is added £1,098 brought forward, making £8,517. Of this amount £6,000 has been placed to the general reserve fund and £1,750 to the maintenance ship's reserve fund, leaving £767 to be carried forward. The meeting was held on Tuesday at Electra House. Our report is held over until next week.

Stock Exchange Notice.—The Committee has ordered to be officially quoted:—United River Plate Telephone Co., Ltd.—further issue of 12,000 ordinary shares of £5 each, fully paid, Nos. 58,001 to 70,000.

Tramways & Light Railways Estates Co.—Mr. Garcke presided at the annual meeting, held at Donington House, W.C., on 28th ult. He said that the profit for 1904 was somewhat less than in 1903, owing to slackness of trade, and to the reduction in the work carried on by tramway companies in connection with the promotion and construction of new lines.

A Fire Claim.—About a month ago a rather disastrous fire occurred on the premises of Mr. Sykes, electrical engineer, Lord Street, Halifax. On the ground that the fire was caused by the Corporation electric wires overheating, the landlord of the building, Mr. Wm. Brear, is claiming damages from the Halifax Corporation.

STOCKS AND SHARES.

Wednesday Evening.

PRICES in the Stock Exchange have developed rather more confidence this week, notwithstanding the continuance of several factors that militate against a return of active business. Other markets had been somewhat dwarfed by that for American rails, where the gamble assumed proportions threatening to the peace of the Stock Exchange as a whole. Money became easier with the turn of the month, but the release of about six millions sterling in dividends and interest at the beginning of the week did not strengthen investment issues to any appreciable extent. Markets, however, have recovered from much of the trepidation that ruled at the time we last wrote in this column.

If the chronicler waxes weary at a monotonous regularity in falls amongst Home Rails, the proprietors of the stocks must have yet stronger sentiments on the subject. City and South London pursues the even tenor of its retrograde movement, the drop this time being 1 per cent., which lowers the price to 42½. The fares are also lower. Waterloo and City declined to the same amount, being now 92, but Central Londons keep steady. As a melancholy curiosity, we may observe that Great Northern and City Deferred £10 shares stand about 30s.; they are fully paid, and were offered to the public at £6 10s. Districts are still dull at 38½, while Metropolitans display further weakness at 95½. The Surplus Lands stock is 75. East London has been negotiated this week at 5¼ and Tilbury Consolidated at 148½.

Electrical Power and Traction varieties are well to the fore in attracting attention from investors. Auckland Electric Trams 5 per cent. Debenture stiffened to 106 upon the excellent account of the company's progress detailed at the meeting the other day. The trio of Metropolitan Electric Tramway issues is quoted *ex* rights, which are valued at 2s. to 3s. for renunciation letters, and the prices of the Deferred, Preference and Debenture are 8s., 20s. 6d., and 106 respectively. Anglo-Argentine Ordinary lost ¼ at 8⅝, there being nothing left to "go for" in the immediate future, although the presidential address dwells upon the unparalleled prosperity of the Republic. Buenos Ayres Grand National "A" Preference are rather firmer at 6. An out-of-the-way stock is the 4½ per cent. Vancouver Power Debentures of the British Columbia Electric Railway Co., and the price does not look dear at 101, about which figure a bargain was done a few days back. The "harnessing" of Niagara Falls has received a good advertisement from the visit of Earl Grey to inspect the work of the Electrical Development Co., of Ontario, last Saturday. Kalgoorlie Electric Preference are still 15s., although the chairman at to-day's meeting announced that the dividend due next October would be paid.

Something like their old form is being shown by Metropolitan Electric Supply Ordinary, which have risen 10s. to 18½, with an appearance of going to the round 20; yet the Preference are ⅛ lower at 5⅝, although the price carries four months of dividend in it. St. James' added 5s., and are 14½, the curious quotation being 13⅞ to 14⅝. Why the actual market price of 14 to 14½ should not be given in the *Official List* we do not profess to explain. County of London Ordinary are also 5s. lower at 9, but the 3s. dividend deducted from Edmundson's Preference has been regained. The two Edison and Swan Debenture stocks are each a point to the good at 83½ and 87½.

Other Manufacturing and Miscellaneous shares have one or two noticeable features. British Aluminium "A" Preference are just *ex* 12s., being the two years' dividend on the shares, the price of which has been lowered 10s. to 4½, while the 7 per cent. shares, *ex* 9d., exhibit no change at 5. The company's funding certificates are quoted at 3. A decline of 5s. in Callender's brings the price to 11, but Henley's are unaltered. Babcock and Wilcox again rose smartly to 5⅞ bid, and the Preference keep good at 30s. Westinghouse Preference stick about 3; the Debenture stock was done at 91¼ last Tuesday. A slight advance in Bruce Peebles Preference makes the price 5 1/16, the rise possibly being a sort of welcome to the impending new issue. County of Durham remain strong.

At 51, Indo-European Telegraphs are *ex* 52s. 6d., dividend and bonus, and the price practically means a rise of 12s. 6d. on balance. This is the best achievement in the Telegraph list this week, other changes being of very minor importance. Globe Ordinary rose 5s. to 10⅝, notwithstanding the slight reduction in the full year's dividend, and Eastern Extensions have a similar advance to their credit, at 14½. West Coast of America at 8s. 9d. put on a small fraction, and there are a few *ex* dividend markings that have no significance. Telephone descriptions continue to be very quiet, a point improvement to 102 in National Preferred being the only alteration amongst this group. Telephone of Egypt 4½ per cent. Debenture stock at 103½ is coming into more general favour.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1903.	1903.	1904.	Closing Quotations April 26th.	Closing Quotations May 3rd.	Business done week ended May 3rd, 1905. Highest	Lowest
94,800	African Direct Telegraph, 4 % Debs.	100	4 %	4 %	4 %	99 —102	99 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	2¼ — 2⅝	2¼ — 2⅝	..	..
119,700‡	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	72 — 77	72 — 77	..	..
768,580	Anglo-American Telegraph	Stock	60/6	61s.	23%	60 — 62 xd	60 — 62	60½	..
5,118,210	Do. do. 6 % Pref.	Stock	6 %	6 %	5¾%	106 —107 xd	104 —107	106⅝	105½
5,118,210	Do. do. do. Deferred	Stock	1/-	2s.	Nil	15⅝ — 15⅞	15⅝ — 15⅞	15⅝	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	..	6⅝ — 6¾	6⅝ — 6¾	..	..
15,000,000§	Commercial Cable	$100	8 %	8 %	8 %	230 —240	230 —240	..	..
1,932,856‡	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	4 %	4 %	4 %	97 — 99 xd	97 — 99	98	..
16,000	Cuba Telegraph	10	6¾%	5 %	5 %	8½ — 9	8½ — 8¾ xd	..	..
6,000	Do. 10 % Pref.	10	10%	10%	10%	16½ — 17½	15½ — 16½ xd	..	..
12,981	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	3⅜ — 3⅝	3⅜ — 3⅝	..	..
6,000	Do. do. 10 % Cum. Pref.	5	10%	10%	10%	9⅛ — 9	8½ — 9	..	..
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	101 — 103	101 —103%	..	..
60,710‡	Direct United States Cable	20	8½%	8 %		11¼ — 11½xd	11½ — 11½	11⅞	11½
78,500	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,900, Red.	100	4½%	4½%	4½%	100 —102	100 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	139 —142 xd	139 —142	141	139½
2,000,000	Do. 8½ % Pref. Stock	100	8½%	8½%	..	91 — 93 xd	91 — 93	92⅝	91⅝
1,886,814	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	108 —110	106 —108 xd	106½	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	14 — 14½	14½ — 14⅝	14⅝	14⅜
602,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	105 —107	105 —107	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	4 %	4 %	4 %	100 —102	100 —102	..	..
200,000‡	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	101 —103	99 —101 xd	..	..
180,887	Globe Telegraph and Trust	10	£3 16 7*	5½%	5⅝%	10½ — 10¾	10½ — 10⅝	10⅝	10⅞
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	14⅝ — 14¾	14⅝ — 14¾	14¾	14½
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	24 %	37 — 39	35 — 37	35½	..
50,000	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	100 —102	100 —102	..	..
17,000	Indo-European Telegraph	25	10%	10 %	13 %	52 — 54	50 — 52	50½	..
72,680	Monte Video Telephone Co., Ltd., Ord.	1	3 %	3 %	..	⅜ — ⅞	⅜ — ⅞	..	..
1,988,888	National Telephone, Pref. Stock	100	6 %	6 %	6 %	108½ —109½	108⅜ —109⅛	109½	109
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	100 —102	101 —103	102	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12⅛ — 13⅛	12⅛ — 13⅛	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11¼ — 12½	11¼ — 12½	12½	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅛ — 5⅜	5⅛ — 5⅜	..	..
4,000,000	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	100 —102	100 —102	100⅜	100⅛
1,689,598	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	103¼ —105¼	103¼ —105¼	104⅞	103⅝
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6½%	6½%	1⅛ — 1⅜	1⅛ — 1⅜	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	6 %	6 %	6 %	1⅞ — 1⅞	1⅞ — 1⅞	..	..
100,000	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	99 —102	99 —102	..	..
11,889‡	Reuter's	8	5 %	5 %	..	8 — 8½	8 — 8½	..	..
3,237	Submarine Cables Trust	Cert.	6 %	6 %	6 %	122 —125	122 —125	..	..
58,000	United River Plate Telephone	5	7 %	8 %	..	7 — 7½	7 — 7½	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	..	5 — 5½	5 — 5½	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	107 —109	107 —109	..	..
15,609‡	West African Telegraph, Shares	10	2 %	4 %	..	8 — 8½	8 — 8½	..	..
80,008	West Coast of America, 1 to 80,000 and 53,001 to 53,008	2½	Nil	Nil	Nil	1/16 — 1/8	3/16 — 1/4	..	..
150,000	West Coast of America, 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	4 %	4 %	4 %	100 —102	100 —102	..	..
107,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	..	13½ — 14	13¾ — 14	13 13/16	13½
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	101 —103	101 —103	..	..
563,390	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	103 —105	103 —105	104	103½
68,821	West India and Panama Telegraph	10	Nil	Nil	..	11/16 — 13/16	11/16 — 13/16	..	..
84,568	Do. do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	..	8¼ — 8⅝	8¼ — 8⅝	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	..	8 — 8½	8 — 8½	8 1/16	8¼
80,000‡	Do. do. do. 5 % Debs., Nos. 1 to 1,600	100	5 %	5 %	5 %	103 —105	104 —106	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

40,000	British Aluminium 7 % Cum. Pref.	5	Nil	Nil	Nil	4⅜ — 5⅛	4⅜ — 5⅛ xd	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	4⅛ — 4¼	4⅛ — 4¼	..	..
800,000‡	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	99 — 103	98 —102 xd	..	..
183,301	British Electric Traction	10	8 %	6 %	..	9½ — 9⅝	9¼ — 9⅜	..	..
156,437	Do. do 6 % Cum. Pref.	10	6 %	6 %	..	10⅜ — 11⅛	10⅜ — 11⅛	11⅛	10⅞
1,000,000‡	Do. do. 5 % Perpetual Debenture Stock	Stock	5 %	5 %	5 %	120 — 124	120 —122	121⅛	120
250,000	Do. do. 4½% 2nd Deb. Stock Red.	100	..	..	4½%	98 — 100	96 — 98 xd	97⅝	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	5¾ — 6	5⅞ — 6	5⅞	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6⅛ — 6	6⅛ — 6	6	5¾
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	101 —104	104 —105	102⅝	102½
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	7/16 — 11/16	9/16 — 11/16	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	14/8 to 15/8	14/8 to 15/8	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	Nil	1/2 — 3/4	1/2 — 3/4	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	1⅝ — 2	1⅝ — 2	..	..
125,000‡	Do. do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	92 — 95	92 — 95	..	..
125,000‡	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	79 — 82	79 — 82	..	..
85,000	Callender's Cable Construction shares	5	15 %	12½%	..	11 — 11½	10½ — 11½	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	5 %	5 %	..	5½ — 5⅝	5¼ — 5⅝	5 5/16	..
800,000	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	107 —109	107 —109	108⅝	108
1,968,208	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	92 — 94	92 — 94	94	92½
525,396	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	101 —103	101—103	102½	..
528,396	Do. do. Def. do.	Stock	4 %	4 %	4 %	82 — 85	82 — 85	..	..
1,320,000	City and South London Railway	Stock	3½%	2¾%	2½%	43½ — 44½	42 — 43	43½	42
85,000	Crompton & Co., Nos. 1 to 85,000	8	5 %	2½%	..	2 — 2½	2 — 2½	..	..
100,000‡	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	5 %	5 %	5 %	93 — 98	95 —100	..	..
99,361	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,361	5	Nil	Nil	..	1 — 1½	1 — 1½	..	..
17,189	Do. do. "A" shares, 01—017,189	5	Nil	Nil	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..
344,063‡	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	80 — 85	82 — 87	..	..
100,000‡	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	85 — 90	86 — 89	90	89
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	..	1⅞ — 1⅞	1 — 1⅛	..	..
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	7 %	7 %	..	2⅛ — 2⅜	2⅛ — 2⅜	..	..
230,000	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	4 %	4 %	4 %	97 — 99	96 — 99	97	..
95,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9½ — 10	9½ — 10	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	97 — 101	97 — 101	..	..
200,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	15 %	15 %	11½ — 12½	11 — 12	..	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	5⅜ — 5⅝	5⅛ — 5⅜	5⅜	..
45,300	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	109 —111	109 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10%	..	16 — 17	16 — 17	16	..
800,000‡	Do. do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	100—103	100 —103	..	..
27,500	†Liverpool Overhead Railway, Ord.	10	1¼%	1¾%	1¼%	3½ — 3⅝	3½ — 3⅝	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	9½ — 9¾	9½ — 9¾	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	36 — 38	36 — 38	36½	34
150,000‡	Do. do. 6 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	103 —105	103 —105	..	..
540,000‡	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	92 — 94	91 — 93	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List

Bank rate of discount 2½ per cent. (March 9th 1905).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years 1902.	1903	1904.	Closing Quotations April 26th.	Closing Quotations May 3rd.	Business done week ended May 3rd, 1905. Highest	Lowest
19,877	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	£ 5	8 %	10 %	10 %	9½ — 10½	9¼ — 10½	10¼	9¼
10 623	Do. do. 7 % Cum. Pref. ..	5	7 %	7 %	7 %	9½ — 10½	9½ — 10½	..	..
188,782	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	105 —108	105 —108	108	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	7½ — 9½	7½ — 8½	8 1/16	..
80,000	Do. do. do. 4½% Cum. Pref. ..	5	4½%	4½%	4½%	5⅝ — 6⅜	5⅝ — 6⅜	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	4½%	4½%	4½%	5 — 6⅛	5 — 6⅛	5 1/16	..
40,000	Do. do. 1903	5	..	4½%	4½%	5 — 6⅛	5 — 6⅛	..	..
350,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	105 —107	105 —107	106⅜	..
14,486	*Chelsea Electricity Supply, Ord.	5	4⅜	5⅛	6 %	6½ — 7	6½ — 7	6 1/16	6 1/16
150,000‡	Do. do. % Deb. Stock Red.	Stock	4½%	4½%	4½%	109 —111	109 —111	110½	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	..	..	6 %	11 — 12	11 — 12	11 1/16	11⅛
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	12¼ — 14	12¼ — 14	13 1/16	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	5 %	5 %	5 %	123 —127	123 —127	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	4½%	4½%	4½%	103 —105	103 —105	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½	9 — 9½	8⅝ — 9½	..	..
80,000	Do. do. do. 6 % Pref., 40,001—60 ..	10	6 %	6 %	6 %	12 — 12½	12 — 12½	12⅝	..
400,000‡	Do. do. 4½% Deb. Stock	..	4½%	4½%	4½%	111 —114	111 —114	113½	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	4½%	4½%	4½%	104 —106	102 —104 xd	105⅞	103½
70,000	Edmundson's Electric Corporation, Ord. Shares	£	..	7 %	..	£3 — 6½	5⅝ — 6½	6½	..
80,000	Do. do. 6 % Cum. Pref.	£	6 %	6 %	..	6⅛ — 6⅝	6⅛ — 6⅝xd	6 5/32	6 3/16
800,000‡	Do. do. 4½% 1st Mort. Deb. Stock ..	100	4½%	4½%	4½%	106 —108	106 —108	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12½	12 %	12 — 13	12 — 13	..	..
136,000	Do. do. do. 4 % Debenture Stock ..	Stock	4 %	4 %	4 %	101 —103	101 —103	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	£	Nil	Nil	3 %	2½ — 3⅜	2½ — 2⅝	..	..
6 670	Do. do. do. 6 % Pref.	£	6 %	6 %	6 %	5¼ — 5⅝	5¼ — 5⅝	..	..
871,845	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	4 %	4 %	4 %	99 —101	99 —101	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	7½	8⅜	10 %	17½ — 18½	18 — 19	18⅝	18½
76,121	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	4½%	4½%	4½%	5⅝ — 5⅞	5½ — 5⅝	5⅝	5⅝
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	4½%	4½%	4½%	103 —114	109 —114	..	..
950,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	3½%	3½%	3½%	97 — 99	97 — 99	100	99½
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	99 —101	99 —101	99⅞	99⅜
10,853	Notting Hill Electric Lighting	10	b	b	7 %	14½ — 15½	14½ — 15½	14⅞	14⅜
59,000	Do. do. 4% 1st Mort. Deb.	100	4 %	4 %	4 %	100 —102	100 —102	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	£	14½	14⅝	14½	13½ — 14½	13⅞ — 14½	14 1/16	14⅛
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	£	7 %	7 %	7 %	8¼ — 8¾	8¼ — 8¾	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	3½%	3½%	3½%	98 —100	98 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	£	3⅛	4 %	4 %	3⅛ — 3½	2⅝ — 3⅛	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	79 — 83	79 — 83	..	..
65,000	South London Electricity Supply, Ord.	£	1½	3 %	4 %	3½ — 4½	3½ — 4½	..	..
100,000	South Metropolitan Electric Light and Power (Ord.	1	Nil	Nil	Nil	⅛ — 1	1/16 — 1/8	..	..
50,000	(*Late Blackheath and Greenwich* 7 % Pref.	1	Nil	7 %	7 %	1 1/16 — 1 1/32	1 3/32 — 1 1/32	..	..
100,000	*Dist. E.L.Co.*) 4½% 1st Deb. Stock	100	4½%	4½%	4½%	105 —108	105 —108	..	..
80,000	Urban Electric Supply, Ord.	£	b	5 %	5 %	4 1/16 — 5 1/16	4 1/16 — 5 1/16	5 3/32	..
80,000	Do. do. 5 % Cum. Pref.	£	5 %	5 %	5 %	5 — 5¼	5 — 5¼	5 3/32	5 1/16
200,000	Do. do. 4½% 1st Mort. Deb. Stock Red ..	100	..	..	4½%	104 —106	104 —106	105½	..
110,000	Westminster Electric Supply, Ord.	£	12 %	13⅛%	14 %	12½ — 13½	12½ — 13½	12⅝	12⅜
28,151	Do. do. 5 % Cum. Pref.	£	5 %	5 %	5 %	6 — 6½	6 — 6½	..	..

Shares not officially quoted :—Mackay Companies, ord., 41½—41¾. Pref. 74—74½.

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, May 3rd.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£5 5	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£18	..
h Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£22	..
a Lead, Nitrate	per ton	£26	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potassium Bichromate, in casks	per lb.	8d.	..
a Potash, Caustic (75/80%).. ..	per ton	£22	..
a Potassium Cyanide	per lb.	7½d.	..
a Shellac	per cwt.	165/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£8 10	..
a ,, Recovered	per ton	£6 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£8	..
Sodium Bichromate, casks ..	per lb.	2½d.	..
,, Cyanide	per lb.	7d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots ..	per ton	£180	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
b Babbitt's metal ingots	per ton	£48 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	..
c ,, Tube (brazed)	per lb.	9¾d.	..
c ,, ,, (solid drawn).. ..	per lb.	9d.	..
c ,, Wire, basis..	per lb.	8d.	..
c Copper Tubes (brazed)	per lb.	10¾d.	..
c ,, ,, (solid drawn) ..	per lb.	10¾d.	..
g Copper Bars (best selected ..	per ton	£80	£2 dec.

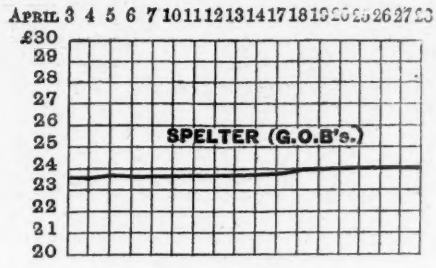
METALS, &c. (*continued*).		Latest Price.	Fortnight's Inc. or Dec.
g Copper Sheet	per ton	£80	£2 dec.
g ,, Rod	per ton	£80	£2 dec.
e ,, (Electrolytic) Bars ..	per ton	£70 10	..
e ,, Sheets ..	per ton	£87	..
e ,, ,, Rod ..	per ton	£81	..
e ,, ,, H.C. Wire	per lb.	9 1/16	1/32d. dec.
f Ebonite Rod	per lb.	8d	..
f ,, Sheet	per lb.	8/-	..
a German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	6/- to 7/-	..
h India-rubber, Para fine	per lb.	5/6½ to 5,7½	..
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	£2,9	2/9 inc.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£12 17	5/- to 7/6 dec.
g ,, ,, Sheet	per ton	£14 5	5/- dec.
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£7 7 6	..
d Mica (in original cases) small ..	per lb.	6d. to 1/	..
d ,, ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, ,, large ..	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/3	..
p ,, ,, strip & sheet	per lb.	1/3	..
o Platinum	per oz.	82/6	..
e Silicium Bronze Wire	per lb.	10½d. to 11½d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£68	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£137 to £138	£1 dec.
n ,, Wire, Nos. 1 to 16	per lb.	1,8½	1d. inc.
p White Anti-friction Metals—			
"White Ami" brand ..	per ton	£48 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5½d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4½d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4½d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh's (Vieille Montagne bnd.)	per ton	£26 17 6	..

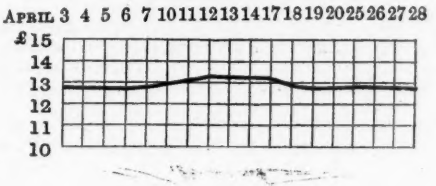
Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co., *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

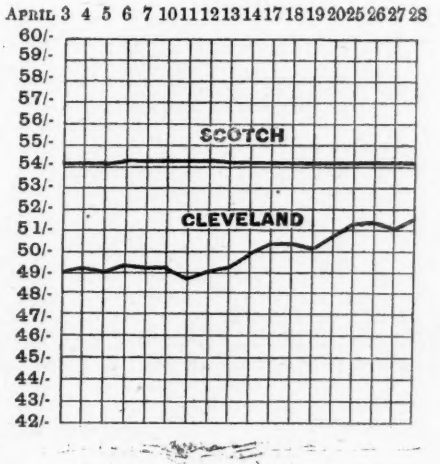
Röntgen Ray Congress at Berlin. — The Berlin correspondent of the *Standard* says that at this Congress, which was opened at Berlin early in the week, 500 experts in the use of the Röntgen rays were present, including representatives of the British Röntgen Society. "Prof. von Leyden read a paper on the importance of Röntgen photography in the treatment of spine and vertebra. Prof. von Grunmach, who was associated with Leyden in the experimental treatment of these diseases with the help of Röntgen rays, read a supplementary paper citing many cases of unusual interest in which Röntgen rays were successfully employed. He referred principally to the use of the rays in ascertaining the nature of diseases of the heart and lungs, especially enlargement of the heart. Prof. Grunmach also gave details of the use of Röntgen rays in treating diaphragmatitis, diseases of the stomach, liver, kidneys and other internal organs. Dr. Cassierer read a paper on the use of the rays in investigating diseases of the brain; Prof. Hoffa described their value in orthopædic surgery; Prof. Lenharts and Dr. Kissling described their experiences in localising gangrene of the lungs by this means. Prof. Lenharts stated that 90 per cent. of the cases of gangrene of the lungs were fatal before surgical treatment became possible. Since surgical treatment was rendered possible by the use of Röntgen rays, Lenharts found in cases which came under his observation over 60 per cent. were successfully treated, leading to the recovery of the patients. Röntgen rays alone had brought about this remarkable change. Prof. Mueller described the use of the rays in dentistry; and Prof. Eberleyn their use in veterinary surgery."

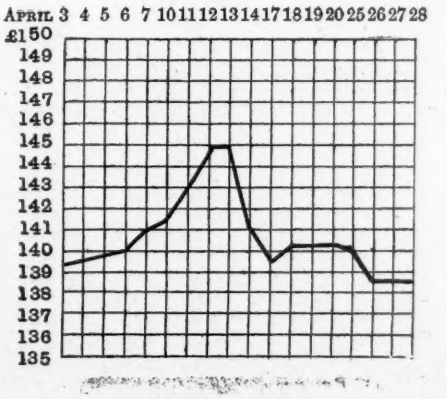
METAL MARKET.

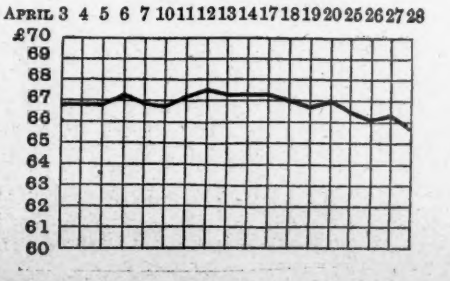
Fluctuations in April.











INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution held on April 27th, the following list of Council nominations for the election of the Council and honorary officers for 1905-6 was announced:—

As President.—*Mr. John Gavey, C.B.

As Vice-Presidents.

*Dr. R. T. Glazebrook, F.R.S.	Mr. W. H. Patchell.
*Mr. J. E. Kingsbury.	Mr. W. M. Mordey.

As Members of Council.

Mr. T. O. Callender.	Mr. J. S. Highfield.
*Mr. W. A. Chamen.	Mr. H. Hirst.
*Mr. W. Duddell.	*Mr. Walter Judd.
*Col. H. C. L. Holden, R.A., F.R.S.	*Mr. Gisbert Kapp.
Mr. S. Z. de Ferranti.	Mr. C. H. Merz.
Mr. F. Gill.	Mr. C. P. Sparks.
Mr. F. E. Gripper.	Mr. G. Marconi.

*Mr. C. H. Wordingham.

As Associate Members of Council.

*Mr. Albert Campbell.	Mr. T. Mather, F.R.S.

Mr. A. J. Walter.

As Honorary Auditors.

Mr. F. C. Danvers.	Mr. Sidney Sharp.

As Honorary Treasurer.—Mr. Robert Hammond.

As Honorary Solicitors.—Messrs. Wilson, Bristows & Carpmael.

* Nominated to fill the vacancies in the Council in accordance with Article 45 of the Articles of Association.

All the honorary officers, being eligible, are nominated for re-election.

COMMUTATION IN A FOUR-POLE MOTOR.

By J. K. Catterson-Smith.

(*Abstract of Paper read at Birmingham on March* 15th, 1905.)

Last year the writer carried out some investigations with a view to recording with a Duddell oscillograph the actual manner in which the current was reversed during commutation. The machine tested was a small four-pole Westinghouse rotary converter, which was used as a 6-H.P. shunt motor running at 1,200 r.p.m. on a 110-volt circuit. The motor had four brush arms, with one carbon brush, $1\frac{5}{8}$ in. × $\frac{1}{2}$ in. thick, per arm. Each commutator segment was 10 mm. wide with 0·5 mm. insulation, and the brush covered 1·21 segments. The output was measured by a brake. The armature circuit was cut, and the two ends were connected to a pair of slip rings, the brushes on these rings being joined together by a strip of manganin sufficient to give about $\frac{1}{4}$ to $\frac{1}{2}$ volt "drop" at full load; the oscillograph was connected across this strip, and thereby showed the current in that particular coil at any instant.

Fig. 1 shows the armature circuit, this being a four-pole wave winding of the chord type. With this type of winding the four sides of the two coils do not arrive at the geometrical neutral point at the same instant, and if four brushes are used, this causes a considerable circulation of current between the two brushes of the

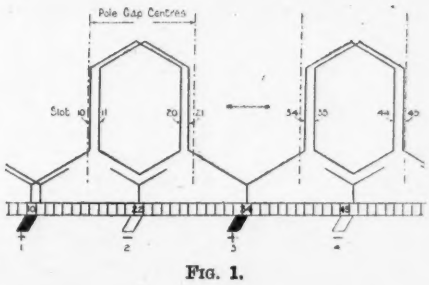


Fig. 1.

same polarity. This occurs to some extent in all wave windings where there are as many brush arms as poles, and involves a heating loss. There were 47 commutator segments, and as the brush rocker was symmetrical, one brush started commutating half a segment before the other brush of the same polarity. This is shown in fig. 2, which is a record of the commutation curves with the brushes at the geometrical centre, for brush No. 3 alone, No. 1 alone, and both down. The load was 3·6 B.H.P. at 1,200 r.p.m., with slight sparking in each case. The brush density was 65 amperes per sq. in. with one, and 32·5 amperes per sq. in. with two positive brushes. This figure also shows the width of a segment and brush, which is the same for all the figures. When both brushes are down, the period of commutation is prolonged, and as shown in fig. 2 the current dies away more slowly, so that the conditions for sparkless commutation are better.

Fig. 3 was taken with only two brushes down, viz., one brush of each polarity—Nos. 2 and 3. This shows the commutation curves

at 60 per cent. of full load, with forward and backward lead of various amounts.

The following table gives the lead of the brushes for the various curves in fig. 3:—

Curve.	Lead. Fig. 3.
A	$1\frac{3}{4}$ segments backward.
B	$1\frac{1}{2}$ " "
C	1 " "
D	$\frac{1}{2}$ " "
E	0 geometrical neutral.
F	$\frac{1}{2}$ segments forward.
G	1 " "
H	$1\frac{1}{2}$ " "
B.H.P.	3·6
Brush density	65 amperes per sq. in.

There was excessive sparking at both limits, and practically none at the neutral point.

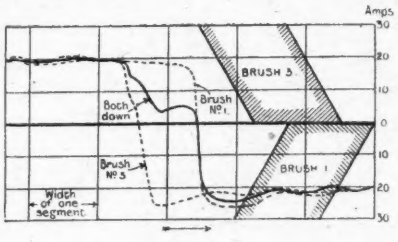


FIG. 2.

Fig. 4 shows the curves of commutation with four brushes. The heavy circulating currents between the two brushes of the same polarity are shown in these curves. On referring to fig. 3, it will be

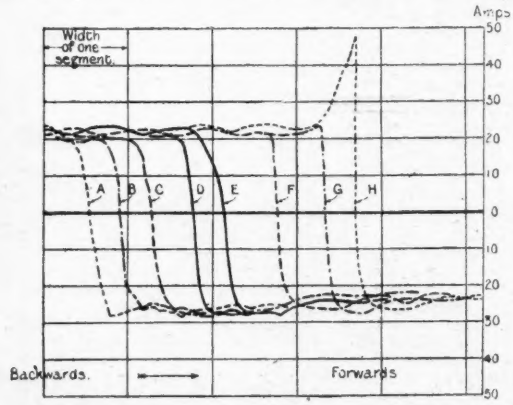


FIG. 3.

noticed that, with two brushes only, the circulating currents do not occur. When the brushes are in extreme positions, the effect of the armature teeth is very marked; this may be compared with the

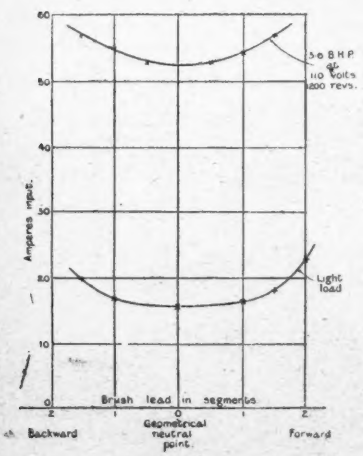


FIG. 5.

armature current curves published by Dr. D. K. Morris and the writer in January, 1904, in the *Journal*, I.E.E., 1904, Part 168, Vol. 33.

The table in the next column gives the lead with which the various curves were obtained, also the motor input.

These curves show very clearly the desirability of using as narrow a brush as possible on a motor with a large polar arc, in which the neutral zone is small. A wide brush soon has one or other edge in contact with conductors in a comparatively strong field, which will certainly produce heavy short-circuit currents.

Curve.	Fig. 4. Lead.	Fig. 4. Motor current.
A	$1\frac{1}{2}$ segs. backward	57 amperes.
B	1 " "	55 "
C	$\frac{1}{2}$ " "	53 "
D	$\frac{1}{2}$ " forward	$52\frac{1}{2}$ "
E	1 " "	$54\frac{1}{2}$ "
F	$1\frac{1}{2}$ " "	57 "
B.H.P.	3·6	
Brush density.	33 amperes per sq. in.	

In fig. 5 the input of the motor is plotted against the lead of the brushes, for light load and half load, with four brushes down, and gives some idea of the increased loss which results through wrong brush position. This loss goes in increased heating of the armature and commutator.

The calculation of the reactance voltage of a coil undergoing short circuit is now usual in designing a continuous-current motor; and the

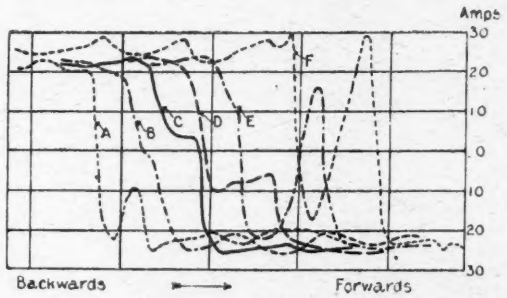


FIG. 4.

method most often adopted is that proposed by Mr. Hobart. The change of current in the armature coil during the commutation interval is assumed to follow a sine law, the reactance voltage then being

$$2\pi n L C$$

when n = the equivalent frequency of commutation

and $= \dfrac{\text{peripheral speed of commutator}}{2 \times \text{brush thickness}}$.

L = the inductance of the coil, in henrys.

C = the current in the coil.

The usual method of calculating L for normal slotted armatures is to assume that a conductor embedded in a slot has 4·0 lines per cm. linked with it per ampere, and that the free lengths, *i.e.*, the end connections, have 0·8 line per cm. per ampere. These figures are

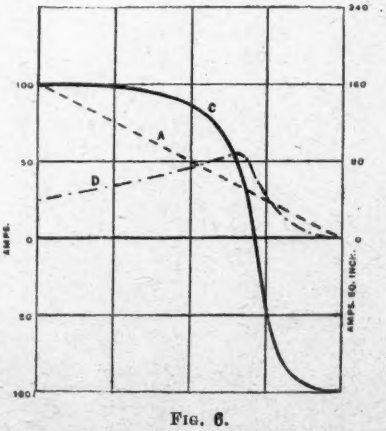


FIG. 6.

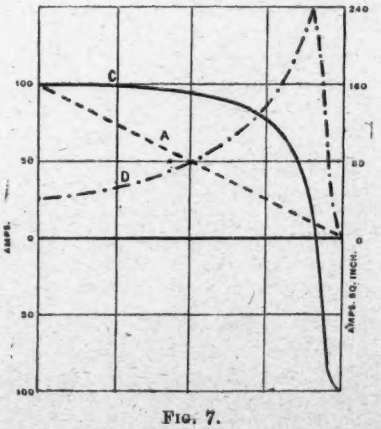


FIG. 7.

the result of tests by Mr. Hobart, and apply to slots with a ratio of depth to width of about 3 to 1.

In the case of the four-pole wave winding with four brushes down, it is evident that there are two paths by which a coil is short-circuited during commutation:—

1. By two brushes and their connector.
2. By two coils in series, and the brush bridging the two adjoining segments.

When only two brushes are used the first case cannot occur.

Calculation of Reactance Voltage.

Peripheral speed of commutator, inches per second		=	390
Thickness of brush, inches		=	0·5
Frequency of commutation, cycles per second ...	(n)	=	390
Width of segment (including insulation), mm. ...		=	10·5
Maximum number of coils short-circuited under a brush		=	2
Turns per coil...	(q)	=	2
Maximum number of simultaneously commutated conductors per group	(r)	=	8
"Free length" per turn, cm.	(s)	=	41
"Embedded length" per turn, cm.	(t)	=	32
Lines per ampere-turn per cm. of "free length"	(u)	=	0·8
Lines per ampere-turn per cm. of "embedded length"	(v)	=	4·0
Lines per ampere for "free length" $\left(\frac{r}{2} \times u \times s\right)$	(o)	=	131
Lines per ampere for "embedded length" $(r \times v \times t)$	(p)	=	1,024
Total lines linked with short-circuited coil per ampere	$(o+p)$	=	1,155
Inductance per segment $q\,(o+p)\,10^{-8}$, henrys ...	(L)	=	·0000231
Reactance per segment $2\,\pi\,n\,$L		=	·0567
Current at full load per circuit, $\left(\frac{78}{2}\right)$ amperes ...	(C)	=	39
Full load "*Reactance Voltage*," volts		=	2·2

This figure, 2·2 volts, is the minimum sparking figure, being due to one coil only. The worst case is with two brushes only, when the voltage becomes 4·4. If four brushes are down, the voltage is probably between these two values.

The sine curve is probably rarely met with, and the method of calculating the reactance voltage gives little more than a guiding figure; however, as a guide, this figure is very useful, especially in the comparison of similar types of machine. The best practice is to design a machine with its reactance voltage less than the brush drop whenever possible, especially with reversible motors having a fixed brush position.

It is permissible to work with a higher value of reactance voltage on small than on large machines; on the other hand, it is generally possible, without much trouble, to keep the figure down on small machines, whereas large machines work more nearly at the maximum value allowable.

Small machines with stiff fields are usually designed with a reactance voltage of about 2·0, although 4·0 volts will usually be satisfactory. With large machines it is difficult to keep the figure below 3·5 to 3·0 volts. With variable speed motors, &c., which have to work with fixed brush position and weak fields, there is no reversing field to help commutation, and the reactance voltage must be kept below 1·0 to 1·5 volts. These figures, of course, do not apply to machines with special commutation poles, in which the existence of a definite and fixed reversing field simplifies commutation immensely, and allows of three or four times the values given above.

In dealing with the problem of sparkless commutation, we are chiefly interested in what is occurring while a segment is leaving the brush, and the part played by the self-induction of the coil. The effect of the self-induction of the short-circuited armature coil is first to prevent the current in the coil dying away quickly, and then to retard the growth of the current from the other side of the armature, tending to a continuation of the current in the rapidly diminishing contact-area of the brush and retreating segment. It is thus seen that the inductance of the coil causes the current density in the brush tip to rise to high values, as is shown diagrammatically in figs. 6 and 7, C being the current commutation curve, A the contact area between the retreating segment and the brush (thickness equal to one segment), and D the current density in the brush tip.

The preceding oscillograms show that the current curve is usually very late in reversing, and consequently the current density reaches very high values, rendering the brush tip very hot, sometimes incandescent, with resulting disintegration and sparking.

The limit to the permissible density depends upon the shape of the curve, *i.e.*, how long the high density lasts in comparison to the interval of short circuit; it seems to the writer that with a curve similar to fig. 7 the peak should not exceed about 300 amperes per sq. in. with ordinary carbon brushes. Experiments upon this point should be of great value. Fig. 6 is a typical case in which conditions obtain suitable for sparkless commutation, the brush density curve being flat. Fig. 7 shows the effect of increased self-induction in the coil, the reversal being late, and the current density rising from 40 amperes per sq. in. to 240 amperes per sq. in.

It will be noticed that for nearly half the time the density exceeds 100 amperes per square inch.

From the above it is clear that the question of current density in the brush tip is of the first importance, to neglect the consideration of which is as if a gas engineer designed his cylinders to withstand the mean pressure of the explosion, instead of the maximum pressure.

In conclusion, the writer wishes to express his thanks to Mr. G. A. Lister, of the Birmingham University, for his help during the tests referred to in this paper.

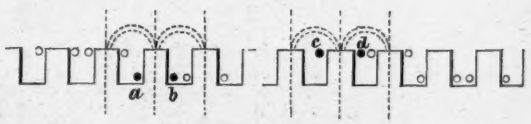
Discussion.

Mr. H. M. Hobart (in a written communication) said that the agreement between the oscillograph records, and the results shown in fig. 5 for the test of amperes input with varying brush leads were most interesting. He had published a hypothetical curve corresponding to the lower curve of fig. 5, at a venture in July, 1902 (fig. 24 on p. 140 of Vol. 4 of "Traction and Transmission"), and had suggested that such tests would give information of great value. He was surprised to see that the curves of fig. 5 were symmetrical on both sides of the neutral point; it would be interesting to know whether this would still be the case at higher loads. Similar tests with various grades of brushes would be replete with interest, and also tests with a given grade of brush, but with various thicknesses. A thorough investigation of various qualities and widths of brushes by means of the oscillograph might lead to some better criterion of commutation than the "reactance voltage," which, while it was useful pending the appearance of a truer guide, could undoubtedly be superseded to advantage.

Mr. C. C. Hawkins (in a written communication) said that the value of such experiments as those of Mr. Catterson-Smith to the manufacturer need not be enlarged upon; but he would like to draw attention to the necessity for a great many more experimental determinations than had yet been made, of what was the apparent inductance of armature coils, upon which commutation depended. The armature should be in place within its field, and the field-windings should be closed upon the armature winding, and further, the magnet should be fully excited. Too often one or other of these conditions had been overlooked; yet they were of great importance, since in actual working the damping action of the field-magnet and its poles, especially when solid, caused the apparent inductance which affected commutation to be much less than the true inductance. While recognising to the full the importance of the attention which had been directed by Messrs. Parshall and Hobart to the so-called "reactance voltage" of the coil undergoing short-circuit, he could not but regard it as most unfortunate that the underlying idea had become involved with a sine-wave assumption. Reactance was a relation purely dependent upon a sine-wave rate of change. Such a condition never occurred in practice, and was, indeed, entirely opposed to the facts. As we did not know the real $\frac{di}{dt}$ in default of an oscillogram such as those of the paper, why did not we confess our ignorance and remain content with the expression $(\text{L} + \Sigma\,\text{M})\,\frac{2\,\text{J}}{\text{T}}$ as a guide to the "inductive voltage"? Where—

L = The self-induction of the coil.
Σ M = The sum of all the coefficients of mutual induction in the simultaneously short-circuited coils.
J = Current per armature section.
T = The entire time of commutation.

Mr. Catterson-Smith was fully alive to the fact that the sine hypothesis was far removed from the truth, and recognised that we could only obtain a "guiding figure." Of course, the above expression was, in exactly the same way, only a guiding figure, being $\frac{2}{\pi}$ of the "reactance voltage"; but as it simply took the average rate of change of the current, it was free from any assumption, and the actual form factor might be left to be added when further experience had been accumulated. In the calculation of L + Σ M, he believed that Mr. Catterson-Smith had assigned too great an effect to the core inductance in his particular case, its amount being estimated as ·0000205 out of a total of ·0000231 henrys. Different proportions of slot and different distributions of winding caused the inductance to vary so very widely, that it was safer to make even an approximate calculation of each component rather than to rely on an assumed figure of 4 lines per cm. and per ampere. An attempt at a fuller analysis of the various components of the inductance had been published by him in the *Electrical World and Engineer*, Vol. XLII., the object being to give a method for calculation on a definite system, so that the results should be strictly comparable. To check such a system, the experiments to which he had just alluded were required. The distribution of the short-circuited wires in a pair of interpolar gaps would be as shown in the following sketches, where the considered section was marked black:—



The case of a coil-side divided between two slots was not dealt with in the above-mentioned articles, but on the same principles as therein given, the slot inductance, self and mutual, worked out as follows:—

(a)	11·52 ×	depth of slot / width of slot	×	length of core ×	10^{-8}
(b)	16·77	"		" "	"
(c)	2·09	"		" "	"
(d)	4·19	"		" "	"
Total	34·57 ×	4·06 ×	·16	×	10^{-8} = ·00000224 henrys.

This assumed that the wires came right up to the top of the slots, and would require a little alteration if there were wooden wedges at the top, the ratio of depth of slot to width in the above being reduced; but a further item was required for the flux that crossed the top of each slot. Owing to the stretch of core occupied by the wires being nearly equal to the width of an interpolar gap, and on the assumption that all variation of the flux entering the pole-tips was damped out therein, the inductance from the surface of the core would be only that due to small local groups of lines arching over the tips of the slots, in which lie the wires of the considered section as shown, and which could be estimated to be ·0000059. The total core inductance would thus be approximately ·00000283, or only about 14 per cent. of that obtained on the assumption of 4 lines per cm. and per ampere. This great difference was to be traced to the chord-winding, to the sub-division of each coil-side between two slots, and to the wide extent of the short-circuited wires as compared with the interpolar gap. If T were the time of short-circuit as reckoned from the width of the brush, the real time of short-circuit in a wave-wound armature with as many sets of brushes as there were poles, was $T\left(1+\frac{x}{y}\right)$, where x was the fraction of a sector which results from number of sectors ÷ number of pairs of poles, and y was the width of a brush expressed in terms of the width of a sector. In the case mentioned in the paper, with four sets of brushes, the time of short-circuit became extended from ·00123 second to ·00123 (1·417) = ·00174 second. For part of this time it was evident that short-circuit was occurring through the leads which connected the brushes of similar sign, so that if the commutation of a single section in a wave-wound armature was treated as above, on the same lines as that of a lap section, a more conservative figure must be allowed for the limit which the inductive voltage might reach.

Prof. THRELFALL had often had machines which ran very well for a short time, but which began to spark when thoroughly heated. He believed that freedom from sparking in machines was obtained by the careful design of small details, rather than by any special feature.

Mr. W. BREW had had to deal with many sparking troubles. Two large two-pole machines had developed flats on the commutator. The cause was traced to the lifting of the armature every time the cranks arrived at the dead centre, causing the brushes to jump. This was got over by raising the magnets so that the magnetic reluctance on the top side of the armature was increased, while that on the lower side was reduced. The connections were also altered, so that the point of commutation was not affected by the dead centres. Another case was that of two machines driven tandem, in which the armatures were not magnetically in a correct position in the field. At some loads this resulted in a violent oscillation of the shaft, which had a bad effect on the commutator.

Mr. A. L. FORSTER asked if the author could give him any information as to where the commutation line cut the zero in relation to the brush. Were any measurements taken of the currents in the cross connections, and, if so, was this current steady?

Mr. MARPLES gave two instances where bad sparking had occurred in four-pole machines having two brushes only. In each case the trouble had been overcome by using four brushes. The author in his paper had clearly shown the reason for this.

Mr. J. K. CATTERSON SMITH, in his reply, said that he could not fix the position of the neutral point with regard to the curves. In the machine he had used for his experiments, the poles were not quite central magnetically, which caused a slight want of symmetry. He did not at the time measure the current in the leads connecting similar brushes, but this had since been done, and the current had been found to be steady. He agreed with Mr. Hawkins as to the advisability of determining the self-induction of armature coils under standard conditions. He could not understand in what way Mr. Hawkins' "inductive voltage" was any more free from an assumption than Mr. Hobart's "reactance voltage;" Mr. Hawkins calculated the average rate of change of current, which assumed a "straight line," while Mr. Hobart assumed a "sine" law. He was interested in the method employed by Mr. Hawkins for calculating the self-induction, and thought it should give a much more reliable figure than the rough approximation given in his paper. He believed that most manufacturers had their own particular sparking criterion, mostly based upon the various works of Messrs. Hawkins, Arnold and Hobart; he would like to point out that in calculating the electromotive forces acting during commutation, it should be noticed that the drop between the brush and segment was nearly constant until very high densities were reached, whereas most writers assumed that it was proportional to the contact area as the segment left the brush.

"EARTHING."

AT a meeting of the Glasgow Local Section of the Institution of Electrical Engineers, held on April 17th, Mr. W. W. Lackie resumed his reply to a discussion on his paper "Earthing." He said that Mr. Munro had found it possible, although troublesome, to slightly insulate the tubing from earth, and towards the close of last evening's discussion Mr. Mackenzie gave most valuable figures, showing that this could be, and had been, done. If dampness, whether it be in plaster, stone or wood, was the only earth path, a further metallic earth connection should most certainly be made, as one could never be certain that the dampness would remain. Mr. Lackie looked to the Electrical Contractors' Association to take up the matter with the architects, and not the supply authorities. The Board of Trade were perfectly right in insisting that the middle wire should be earthed at only one point, and in such a way that the earth connection could be removed if required. The time taken to make their insulation test at Port Dundas station each week was about half an hour. The positive or negative main was earthed through a resistance, and the current carefully taken on the middle wire, or feeder, before and after the earth was made. As to Mr. Newington's remarks, Mr. Lackie said that the Corporation inspectors regularly made a test at the switches and lampholders, to see that the tubing was earthed electrically. He had heard of one or two fires due to the earth wire having been left bare and melting gas pipes. Mr. Mavor drew the conclusion from his paper, that he was coming round to the idea that it was not safe to run electrical conductors without an earth protection. He was most assuredly not coming round to this conclusion. In their early underground work in Glasgow, they started by laying lead-sheathed cables in iron troughs, and they were now definitely convinced that this was quite a mistake. Trouble had been experienced with arcing and fusion between the lead-sheathing and the iron troughs, when the lead got alive by accident. Two alternatives were presented to them—either to use metallic sheathed cables and put them inside a non-metallic box, or to get a non-metallic sheathed cable and put it inside an iron box, in both cases filling the box up solid with compound of some kind. Fortunately for them they had now got a non-metallic sheathed cable, and at present it was laid solid in a wooden box with absolutely no metallic sheath or earth protection, and was proving most satisfactory. The current returning by the tramway rail was not the same as the current which flowed when an earth took place on an electric lighting or power installation. In the case of tramways it was a fixed current, and would divide up in proportion to the conductivity of each path, but, as a matter of a fact, the tramway rails need not necessarily be the earth, but were an earth of their own. He did not understand Mr. Mavor's contention that the real trouble arose, not between one of the conductors and the earth, but between two conductors when the flash took place inside the metal box, or other places where faults occurred. The trouble undoubtedly did occur with one conductor only coming in contact with the metal sheathing, and also the current leaving the metal sheathing and other metal work, and the great difference of potential was practically between the point at which the fault occurred and the earth proper. Mr. McWhirter had very rightly stated that they should abolish Simplex or lighter gauge tubing and use proper screwed tubing. If a consumer got into the habit of inserting larger fuses in faulty circuits until he got one that would stay, no system of earthing would prevent harm coming to that consumer's wiring. Mr. Chamen's remarks were practical and to the point, and he (Mr. Lackie) knew there was one class of engineer who said earth everywhere, and another class who said insulate everywhere. He personally thought that a neutral course could be steered, and each place to be wired should be dealt with according to the nature of the premises. He did not agree with Mr. Morley, who stated that when they raised the pressure in this country to 200 or 250 volts they did this in the interests of the supply authorities only, and not primarily in the interests of the consumers. He was perfectly certain that had the Glasgow Corporation stuck to the old 100-volt supply, their capital expenditure on mains alone would have been half a million more than it is, and the consumer had to pay for this.

PHYSICAL SOCIETY.

AT the meeting held on April 14th, 1905, Dr. R. T. Glazebrook, F.R.S., Past-President, in the Chair, Mr. R. J. SOWTER read a paper on "Ellipsoidal Lenses."

A paper on "The Determination of the Moment of Inertia of the Magnets used in the Measurement of the Horizontal Component of the Earth's Field" was read by Dr. W. WATSON. One of the constants required when determining the horizontal component of the earth's magnetic field by the ordinary method is the moment of inertia of the magnet which is used in the vibration experiment. It is usual to determine the moment of inertia of the cylindrical brass bar supplied with each instrument by calculation, then, by measuring the period of the magnet alone, and when loaded with this bar, to calculate the moment of inertia of the magnet. This method presupposes that the density of the inertia bar is uniform throughout. It is not easy to secure a bar of which the density is uniform throughout, and further it is difficult to test whether such uniformity has been secured. The author thinks that more reliable and uniform results would be obtained by determining once for all, with very great care, the moment of inertia of a standard bar, and then determining the moment of inertia of the bars supplied with the different magnetometers, by comparing them with the standard bar experimentally. In the paper is described an instrument suitable for comparing the moment of inertia of bars, together with some experiments made with a view to determining the moment of inertia of a standard bar, and an investigation of the influence of the air upon the period, the latter being of the order 0·1 per cent.

Dr. C. CHREE remarked that the want of homogeneity in inertia bars was a source of serious trouble in magnetometer work. The variation in density might be as much as 5 or even 10 per cent. He favoured the adoption of a standard bar which could be swung in various magnetometers.

Dr. W. WATSON afterwards gave an "Exhibition of a Series of Lecture Experiments illustrating the Properties of the Gaseous Ions produced by Radium and other Sources."

BOILER FURNACES AND THE EFFECT OF OIL.

The gist of a paper by Mr. D. B. Morison, read before the North-East Coast Institution of Engineers, is to the effect that no ordinary furnace fails from lack of strength if clean and covered with clean water. Failure is a result of scale, of dirty water, and, above all, of oil, a very thin smear of which has an altogether unexpected effect on boiler furnaces.

The Board of Trade and Lloyds, and other registration societies, assign strength to furnaces by placing them under hydraulic pressure until they collapse; the collapsing coefficient thus determined is $C = \frac{PD}{t}$, where P = pressure per sq. in., D = outside diameter in inches, and t = thickness in inches

The author sets very little value, however, on cold testing, and the strength shown thereby, and this view he holds to have been proved sound by the fact that furnaces which show good cold test results have been displaced by furnaces showing no better cold test figures.

All types of corrugated furnaces enable larger diameters to be employed, and a large furnace is favourable to boiler efficiency. At present the Board of Trade allows the same strength coefficient for all diameters, but the author would provide a decreasing coefficient above 42 in. diameter, especially for forced draught conditions.

The author states that the strength of a plain tube varies directly as the thickness and inversely as the diameter, but larger diameters are weaker than the simple diameter ratio. He then discusses modern furnaces in the light of scale accumulation. A plain furnace with flanged seams or Bowling hoops is like a flat beam carried by girder rings, and if the straight part be softened by heat it will bend down and simply hang on the rigid rings.

The Fox flue was all corrugated, and was very strong. The suspension furnace which followed had wider valleys than the Fox flue, and was throughout of uniform thickness. The essence of furnace design is a correct adjustment of the dimensions and curvatures of the inward and outward corrugations, so as to secure the best possible compromise between ideal forms and best practical forms, the two not being alike owing to scale and other factors.

Furnaces must not be so confined longitudinally as to set up expansion stresses; nor should furnace bars be packed tightly in when cold. Any serious restraint caused by bars or by the tubes being too close to the crown may cause trouble, but, given attention to such points and assuming that shortness of water does not occur, a furnace will not collapse unless its walls become heated to redness through oily deposit or excess of scale.

The margin of strength is five; this margin begins to disappear when the furnace plates pass the temperature of 650° F., and it vanishes at a red heat.

Now, steam of 200 lb. pressure has a temperature of 380° F. The temperature of 650° as above marks the commencement of loss of tenacity of steel. At 1,200° F. some 75 per cent. of the original tenacity has gone. A clean furnace simply rubbed over with a very thin coating of mineral oil will at once rise to over 650°, even under light duty.

In a greasy scale recently analysed there was 66·76 per cent. of free oil and 2·95 per cent. of oil in combination with oxides. The sample was from the furnace below fire level.

From the shell at water level the same items became 41·04 and 14·49 per cent. respectively. From the furnace crowns which had been overheated the figures were 0·77 and 4·6 per cent., and from below the tubes 20 23 and 34 104.

The oil used on the steamer on which the above furnaces had collapsed was deficient in quality, and this probably led to an excessive amount being employed. At 360° F. it was inferior to tallow at that temperature, and tallow at 360° is only equal in body to water.

The author recommends the removal of grease before steam enters a condenser, and the use of a minimum of oil, and that of the best quality—not purchased by a mere commercial ignoramus on the lowest-tender basis, which may cost thousands in resulting disasters.

It is not the high grade mineral oils which give trouble, but the low grade stuff, which emulsifies, and cannot be filtered out without chemical treatment.

The author recommends an auxiliary condenser for all auxiliary engines, which should not exhaust to the main condenser.

Written primarily for the marine engineer, this paper should receive attention from the engineer ashore, for there can be no doubt about the trouble which may arise from oil in boilers, whether these be of the shell or of the water-tube type. Why so thin a film of oil should give so much trouble is one of those matters not fully or clearly understood. Sufficient that it does so, and that oil is a most dangerous substance to allow in a steam boiler.

The North-East Coast Institution of Engineers is fortunate in the class of papers put before it, and the present paper by Mr. Morison is excellent.

Gas.—On Monday, at a Southampton Conservative Club, there was a serious gas explosion, wrecking the premises and furniture and injuring three persons. A heavy steam roller is said to have caused the road to give way, fracturing the main and causing the leakage which led to the explosion.

DRIVING ALTERNATORS BY GAS ENGINES.

[COMMUNICATED.]

Though one would perhaps like to have said it differently, the somewhat blunt sayings at page 417 *ante* are expressive of what many of us are thinking to-day. Why should not a gas engine drive an electric alternator? It is all a question of speed and of fly-wheels and though we all know that a heavy fly-wheel acts as a brake, there is the possibility of running it with very little friction in roller bearings. The Ilseder Works referred to is a sample of what might be done in this country, but for its ignorant managers and proprietors. Ignorance, apathy, and want of commercial common sense and sense of common interests are responsible for the multiplication of fuel-using power stations in the middle of districts in which power gas is flaming to sinful waste.

Speak to any one of our self-constituted commercial leaders on economy in commercial power production, and they reply, "we" don't see how this and that and the other can be commercially undertaken, and so on, as though "we" knew it all. Were it the case that they were being asked to pioneer anything, there might be some excuse for them. But they are not even asked to go first. The less wealthy German and the Belgian have gone first, and our great industrial leaders have only to go a tardy third. But is it not a fact that when matters reach the lowest abyss of ignorance and folly they take a rather rapid upward rise in this country? It has been so with machine tools, and it has been so with electrical plant. The United States, considered to be our most dangerous competitor, cannot touch Great Britain in cotton machinery, in machine tools, in steam engines or boilers. Undoubtedly Germany is doing everything possible to step into our shoes, but the German can never change his bent of mind. Only one engineer has boldly faced the problem of gas power for electrical work. Small gas stations have, it is true, been attempted, in some instances with impossible, because costly, illuminating gas, in others with small gas producers which cannot be expected to work well, or with, perhaps, hit-and-miss governing.

For all that the Germans have done, there is both the capacity and the knowledge to do the same in this country. But those who have this capacity have not the power financially, and those who have the financial power have not the knowledge. Why should a water-pumping works run boilers all day, and the electric light station run by night, when a little more than the larger set of boilers would do for both duties?

Business men are apt to complain that engineers do not care for the commercial side of matters, whereas the truth is that, if engineers had their way, they would very quickly find a way to bring about the economies hinted at.

It is to the business man and the lawyer and their fellows that the inert mass of vested interests owes its power to clog all progress.

The men who are doing best for this country are the contractors. Most of the ability in construction is in their hands, and it is because they and their employés get a bigger say in Germany that Germany shines in pioneer work.

THE BOARD OF TRADE REPORT ON THE CUDWORTH ACCIDENT.

The report of the Board of Trade Inspector, Major Pringle, on the circumstances attending the collision which occurred on January 19th, near Cudworth Station, on the Midland Railway, has now been issued, and like all reports made to the Department on such accidents, is a most comprehensive document, and interesting in the highest degree as an instance of the thoroughness with which the investigations are made and the impartial manner with which blame for the occurrence is apportioned. Four passengers, a railway guard and a fireman were killed outright, and another death has since occurred as the result of the injuries received. Twelve other passengers and five railway servants were injured, and, in addition, the Midland Railway Co. sustained heavy losses from the destruction of its stock.

Major Pringle states that the collision was due, primarily, to an infraction of the rules of block working, by the entry, during a heavy fog, of the "up" express into the block section between Cudworth Station South and Stores Mills, when the section was already occupied by the "up" mail train, and considers that either the signalman or the driver of the express is responsible for the breach of the rules. The driver of the leading express engine seems to have relied upon his fireman for the observance of signals which he himself by reason of his position on the engine, was unable to see, and he asserts that he received a hand signal

from his fireman on passing the distant signal to the effect that it was "off." This statement cannot be corroborated as the fireman was killed when the trains collided.

Major Pringle finds that the driver of the leading engine of the express was not justified in relying upon his fireman for observance of the signals under the conditions of the weather at the time, that the breach of block working was due to the "up" express train running past danger signals at a high speed in a thick fog, and that the responsibility for the resultant collision rests mainly with the driver of the leading engine of the "up" express, and in a less degree with the driver of the second engine of that train, inasmuch as he should have recognised that, in view of the fog, the speed at which the train was travelling was not justifiable, and he should have taken upon himself the responsibility of reducing the speed. In addition to this apportionment of blame, Major Pringle points out that in view of the fact that an hour elapsed before the arrangements for calling out the fogmen for duty can be considered to have been properly brought into action, the company's arrangements for fog-signalling cannot be considered to be satisfactory. The responsible fogman, however, is exonerated from blame for delay in reporting himself.

As already stated, the report is an excellent summary of the conditions obtaining at the time of the accident, and the evidence taken during the investigation, and the apportionment of blame is such as would be expected under the circumstances. The first contributing cause to the collision is the existence of the fog; the second is the absence of the fogmen, who are expected to supplement the indications of the ordinary signals exhibited under normal conditions; the third cause is the running past the signals at danger by the "up" express, and the fourth and last cause is the presence of a preceding train in the section. All these conditions had to occur simultaneously—to synchronise, so to speak—in order to bring about the collision. The question of speed, however, on which ground Major Pringle allots a portion of the blame to the driver of the second engine, is outside the contributory causes altogether, and only affects the violence of the collision when it took place. It is somewhat difficult to conceive of what is at the back of the official mind in connection with this question of speed reduction. Railway companies' time-tables make no allowance for delays by fog, and the drivers of trains may justly enough expect that the arrangements for supplementing the ordinary signals will be made when the necessity arises. Moreover, should the fogging arrangements not be made before the fog has become severe, the signalmen are instructed to place fog signals in position for the warning of drivers, and as the signalman knows of the approach of trains to his position, he is in no doubt of the necessity for this action from the knowledge he possesses of the condition of the section ahead. It is, of course, easy to say, in the light of events, that a slower speed would have contributed to the safety of the trains involved in the disaster, but such action would have far-reaching effects, and it would be most difficult to justify it if no collision had taken place, or if no chance of collision had arisen. The drivers of double-engined trains are in a peculiar position. Each is supposed, of course, to see as far as possible that all signals are in order for the passage of the train, but the leading driver is necessarily in a better position to do this than the second driver, as the latter's view may be obscured or obstructed by steam from the first engine. The difficulty of communicating intelligently with each other is great, and the necessity for such communication has not yet been sufficiently realised. The driver of the second engine would naturally expect the leading engine driver to observe the signals, and the latter might just as easily expect the former to confirm or correct the observations. In any case it would seem no very difficult problem to provide apparatus by which signals could be exchanged between the drivers of double-engined trains by which each could inform the other of his impression of the positions of signals as they were passed. Such an arrangement would apportion the responsibility among all the men on the engines, and would reduce the chances of error in proportion to the number of those having cognisance of the signals exchanged.

Leaving this aspect of the subject on one side, it may be well to consider other points raised by such occurrences. Probably the most important of all considerations is the object with which such investigations are undertaken, and reports made to a public department. What has been done with all the numerous and able reports made from time to time in the past? What is the net result of the investigations systematically made for so many years? What will be done as the result of the present report? Is there any circumstance disclosed in Major Pringle's report that has not occurred in some previous accident? Are the conditions leading to the Cudworth accident unique and such as have never occurred before, or are they such as consideration of the conditions under which railways are operated would not disclose? In what respect do the conditions differ materially from those contributing to, say, the Wivelsfield accident in December, 1899, which was commented upon in these columns in the issue for January 12th, 1900; or the conditions obtaining in the accident to the Brighton Pullman train at Bermondsey, which was referred to at the same time? Is it not the case that the conditions under which railway accidents occur now are mere repetitions of two or three variations from normal operation, and that these variations have been pointed out *ad nauseam?* Is the collection of evidence by the Board of Trade a means to an end? Is that end the prevention of the recurrence of the event which has been investigated? If not, why in the name of common sense, are the investigations continued seeing that nothing is elicited more than was known from previous occurrences? Does the Board of Trade quite realise its position towards travellers by railways? Do not the regulations of the department with reference to the safe operation of railways, and the investigations into the causes of accidents when they take place, give the public the impression that the department is in *loco parentis* to them so far as railway travelling is concerned? And yet, what real benefit can be ascribed to the department in this respect? The position at present is undignified, not to say ludicrous. The continual piling up of evidence of the same character, without action to obviate the results, is labour in vain.

The negative result of the labours of the Board of Trade, is the less easily understood when the apparatus designed with a view to prevent just such accidents as that at Cudworth is considered. From time to time, reference has been made in these columns to apparatus designed to give signals direct upon the engines, and many have been described in detail, and commented upon in so far as they seemed suited to the conditions obtaining. The North-Eastern Railway Co., with characteristic enterprise, is leading the way with Raven's system, which whatever its defects may be, provides for the more important signal "on," or "danger," being given. Among systems which have been described in these columns, are:—Brierley's, Boult's, Hoyt's, Miller's, and others which it is unnecessary to particularise further. The system of MM. César and Guarini, which has recently undergone trials on the Belgian State Railways, is one that is capable of great development for use on English railways, and possesses an important and unique characteristic in the equivalent of the projection of the driver's vision, which it provides from the combination of a track circuit under the control of the signalman and working in conjunction with the signal levers, with magnetic relays of simple and strong construction carried upon the engines, which is the chief feature of its design. Such apparatus as is here referred to is necessarily within the knowledge of the Railway Department of the Board of Trade, but unless the use of apparatus which reason and experience shows would tend to obviate accidents is fostered, the Department of State lacks in carrying out its duties to the public at large.

As stated in the article of January 12th, 1900, dealing with the Wivelsfield and Bermondsey accidents—"... the evidence given should furnish lessons which it will be well for the responsible officials to study carefully. The first seems to be that the existing system of supplementary signalling during fogs is of a make-shift character, involving complex arrangements for which there is not always sufficient time, and the exercise of judgement on the part of those who are not in the best position to judge. The system, moreover, is one which, obviously, provides signals of an insufficiently precise and distinct character. ... While rules and regulations are excellent as a means of convicting delinquents, they are insufficient, in themselves, to avert disaster ...;

less dependence upon the observance of rules which are of infrequent application, and greater dependence upon apparatus, would possibly give better results."

In conclusion, a further quotation from the same article is as applicable to the results of the investigation into the Cudworth accident as to the accidents which called it forth.

"But, after all, the accidents . . . . may have good results if the lessons they teach obtain adequate consideration. If, however, the results of the . . . . investigations are politely acknowledged and carefully lost, or if undue prominence is given to the breaches of the rules, as the only contributing causes of the accident the results will hardly be satisfactory. If, on the other hand, the accidents afford an opportunity for the Board of Trade to call the representatives of the railway companies together for the purpose of considering alternative methods of signalling, either as a whole, or as supplements during exceptional conditions, and if a little judicious pressure be exercised the question will be in a fair way for settlement. . . ."

OVERHEAD ACCIDENTS AND THEIR PREVENTION.

We have contended always that the risk of personal injury due to the falling of trolley wires is minute in the extreme. When taking objection to the extravagant and general assertions of opponents of the overhead system, we have drawn attention to the fact that published records, either official, technical or popular, prove the really remarkable degree of safety with which the public have walked or ridden under the thousands of miles of trolley wire which now form a characteristic of our British streets.

That there is a potential danger in every trolley wire we have never denied, any more than we should deny that every tree is a potential menace to those who pass it in a storm, or that the roof over our heads may fall and crush us at any moment. Trees have fallen on unfortunate people, and roofs have given way, but the reasons in every case have been plain, and the accidents have not deterred us from continuing to plant trees or to walk under them in the wind, or to put roofs over our houses. When a roof falls in, it does so because it was not designed with sufficient strength or in such a way as to resist the maximum possible buffets of wind and weather, or because it had not been maintained in proper repair, or from some unforeseen cause such as an earthquake or a subsidence of the ground, or from some external accident such as the fall of another building. If we apply a similar analysis to overhead construction, we find that accidents arising therefrom fall into the same broad divisions. That they do arise is evident from the damage suits which are heard from time to time, and, as our legal contributor has pointed out on several occasions, the owners of the wires are likely to be held responsible in most cases. The three divisions or classes of accident may be termed shortly, accidents arising from defective design or construction, from defective maintenance, and from defective foresight. As the prosperity of a tramway undertaking may depend very much on its immunity from accidents, it is advisable to discuss the risks of each division separately.

1. Speaking generally, an overhead trolley line is composed of the following parts:—Poles, copper wire, stranded steel span wire, wrought-steel or wrought-iron bracket arms and their attachments, insulating hangers, gun-metal ears, special work, such as section insulators, crossings, switches and frogs, accessories such as guard wires and section feeder cables.

Now accidents may occur directly or indirectly from the failure of any one of these components, and may be traced to errors in composition or in treatment during manufacture, or to careless and ignorant erection, or to reduction by wear and tear and exposure, or to damage from some external agency.

As a usual thing specifications are so strict and detailed that if the goods are manufactured and tested in accordance with their terms, the danger of accidents from the first cause is extremely remote, and the proportions of parts has become so standardised that there is hardly an opportunity for errors under that head. There is the chance of designs becoming obsolete owing to developments of service, and that possibility should receive attention whenever the headway of cars is decreased in any considerable degree, or the size of cars and equipments increased. For instance, a line built 10 years ago when cars were small, motors from 10 to 20 H.P. each, and working pressures perhaps less than 500 volts, could not be expected to withstand safely the imposition of heavy cars driven at a higher speed by powerful motors taking current at the maximum pressure allowed. Of course designs are not so much standardised that finality has been reached. On the contrary, there is room for improvement in many details, so far as easy running and diminished wear are concerned, but in the matter of strength when first erected little improvement can be desired.

There is one point touching manufacture that ought to receive more attention, and that is the matter of renewals. From the third to the tenth year, beginning sooner or later after the third year, as the conditions of service are more or less severe, almost the whole of the overhead construction, with the exception of the poles, has to be renewed, and in too many instances the material for these renewals is obtained without the stringent specification of quality, and the insistence on tests which ensured the soundness of the material of which the line was constructed in the first instance. Unfortunately, this tendency is accentuated by the natural inclination, or the compulsory need for reducing the working expenses; but directors and engineers may be assured that the policy of buying the best possible material, if carried out consistently and from the beginning, will keep down the cost per car-mile much more effectually than accepting the lowest quotation with eyes closed to the quality. An accident resulting from a faulty splicing ear or from the defective insulation of a hanger-bolt, is apt to cost an alarming amount more than the difference between ductile gun-metal and brittle brass, or between an insulator of the first quality, and an insulator of any other.

Even with the greatest care in manufacture, it is conceivable that accidents may happen which can be traced directly to a flaw, but that kind of mishap may be classed amongst acts of God without much objection.

Leaving manufacture and coming to erection, we shall find more chances of future accidents being put into the work. Our experience of contractors' linemen may be unfortunate, but it has led to the formation of the opinion that a large percentage are either insufficiently skilled or are careless. Sometimes, of course, the engineer in charge of the job has more of an eye to the speedy and cheap completion of the contract than to the possibilities of trouble some years hence. It is, therefore, of the highest importance that the owners of the tramway should not save the shillings which proper supervision in their interests will cost, at the expense of pounds later on. There are so many openings for mistakes, that Argus himself would be at a loss how to watch them all. A trolley wire pulled up too tight on a hot day is prepared to break at the weakest point, probably where it is a little worn at the ear, next winter. If the soldering iron is too hot when an ear is sweated on, the wire may stretch and break where it has been softened, and that may take years; or a nick through the skin of the wire while the lineman is dressing off the ends of the ear, or bending the end of the wire into a splicing ear; or a span-wire badly nozzled off; all may, in fact, all will give trouble sooner or later, and whether that takes the form of accident, or merely of removing the defective portion, and replacing it with new material before the accident occurs, will depend on the ability of the permanent linemen, a point about which we shall speak later. It is rarely that insulators are damaged during erection, as they require little handling, but accidents have occurred through section-cables being treated foolishly. Of failures and consequent delays and expense due to this one cause we might write for a month, but we do not treat here of anything but accidents which may result in personal injury.

The majority of accidents have occurred from defects which are inevitable results of wear and tear and exposure. The danger from this class of accident is continuous, and becomes intensified as the line grows older; but that is not to say that at any period of the life of the line this danger

need be anything more than potential. Speaking generally, it may be said that the measure of the efficiency of maintenance on any system is the number of accidents on that system.

We have no hesitation in saying that there are very few accidents which do not arise from negligence, which includes ignorance, or from parsimony, and we believe that ignorance, in one way or another, is the chief cause.

We have in England a most useful type of man called a general manager. As a rule he is an excellent organiser and handler of traffic and men, for in many cases he has been acquainted intimately with the traffic department of a tramway from an early age. He has had no training as an engineer, and his *experience* in engineering matters is either nothing or is limited to the contruction and working of a steam tram engine. Of the troubles inherent, and to be expected from first principles, in the overhead equipment of an electric tramway, he knows nothing, except what he learns by experience, and that, as everyone knows, may be dearly bought.

Luckily, he is often a smart man, and would make as good an engineer as most of them if he had the opportunity, so a little experience goes a long way.

After the first unpleasant demonstrations of the effect of wear and tear, or of deterioration, he realises that a broken trolley wire, a stranded span wire, or a failed insulator, are not just extraordinary phenomena, but will be with him always, and increasingly, if he does not take radical measures to avoid them. Gradually, therefore, he organises thorough systematic and periodic inspection, by which alone he is convinced that his troubles are soon to be overcome. If his agents be sufficiently intelligent and painstaking, and the inspections which they carry out be uniformly reliable and are up to concert pitch all the year round, then his hopes will not be dashed, his costs will decrease, his insurance premiums will go down, his line will be an example to all, his passengers will not require nerves of iron or a blissful ignorance in order to enjoy a ride on an uncovered top-deck, and he himself will add years to his life on account of a constant source of worry and anxiety having dried up; that is the happy general manager. On the other side of the page is the unhappy man who lives in a continual state of perplexed surprise at the astonishing number of accidents of one kind and another which occur on his overhead construction. His motormen are looking out for weak places and for groggy insulators all the time they are driving their cars, and the inspectors have even greater opportunities, and more leisure, to take note of any defects; yet the tower-wagon never ceases rushing from one breakdown to another, and matters have come to such a crisis that a proposal to buy a motor-tower-wagon is to be put before the next committee or board meeting. The wire is shocking stuff, the insulators are shoddy, the gun-metal fittings are more like yellow-metal, the line was badly erected in the first place, there is too much tension on the trolleys, the trolley-wheels are too hard, the atmosphere is laden with salt, or chemical fumes, or smoke, or merely moisture, there are a hundred and one things all doing their level best to cause disaster, if one is to listen to the poor man, but the real remedy does not occur to him. Perhaps his troubles are due to some or all of the causes enumerated, but they might be one and all nipped in the bud instead of being allowed to blossom into full-grown accidents.

In the first place, the leakage tests prescribed by the B. of T. can be made more useful than they are, as a rule, considered to be. Every man must decide for himself the limit at which the leakage of any particular route is to be set, and anything over that limiting figure must be reported without delay to the official who is responsible for the distributing system. He will use his discretion as to the urgency or otherwise of turning out to locate the cause of the leak. He knows that if it develops into a fault before he has moved, he will have to explain his inaction. The general manager himself should scan the leakage records daily. It will not take him five seconds to spot anything over the limit, and the knowledge that he is doing so will increase the efficiency of the staff without a doubt.

But the sovereign remedy is inspection followed by repairs, and that programme carried out inflexibly, week in, week out, until the crack of doom, if overhead tramways exist at that uncertain period. No matter how extensive the lines, or how complicated the network, sufficient linemen and apparatus must be provided to ensure every yard receiving the prescribed attention once within a certain fixed period of time.

(To be continued.)

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

8,122. "Improvements in the construction of electric tramways." S. G. Bennett. April 17th.

8,127. "Gasproof disconnecting plug for electrical switches." A. E. Carter. April 17th.

8,168. "Improvements in and relating to electric telegraph apparatus, and in particular to devices for indicating at a distance the position of a pointer, needle or the like." H. Usener. April 17th. (Complete.)

8,196. "Improvements in or relating to multiple unit control for electric motors." T. S. Perkins and R. P. Jackson. (Date applied for under Patents Act, 1901, June 6th, 1904, being date of application in United States.) April 17th. (Complete.)

8,200. "Improvements relating to the transmission of electrical energy." H. H. Lake. (N. Tesla, United States.) April 17th. (Complete.)

8,215. "Improvements in the regulation of the voltage of alternating electric current systems and in apparatus therefor." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 18th.

8,221. "Process for the electro-metallurgical manufacture of metals or alloys free from carbon." G. Gin. April 18th. (Complete.)

8,253. "Electric light hanger for walls." W. H. Liau. (Date applied for under Patents Act, 1901, April 23rd, 1904, being date of application in United States.) April 18th. (Complete.)

8,267. "Improvements in and means for electrically recording weights lifted by a crane, or the like." C. Russo and E. C. Feinstein. April 18th.

8,278. "Improvements in electrical switches." W. S. Mayer. April 18th. (Complete.)

8,305. "Improvements relating to electric wiring and controlling sytems." A. Blackmore. April 18th.

8,326. "An improved switch for electric lighting circuits." J. Hutton. April 19th.

8,330. "Improvement in automatic switches and circuit breakers." J. H. Ward, A. A. Godstone, M. H. Godstone and H. S. Nowell. April 19th.

8,357. "An improved way of administering electricity for medical purposes and apparatus used in connection with same." W. Davenport. April 19th.

8,391. "Improvements in electricity meters." J. D. F. Andrews. April 19th.

8,394. "Improvements in or relating to electric motors." Dr. M. Corsepius. April 19th.

8,409. "Improvements in selecting devices applicable to party line telephone systems and the like." P. Arnheim. April 19th.

8,410. "Improvements relating to electrically operated selecting and switching devices applicable to party line telephone and telegraph systems." P. Arnheim. April 19th.

8,411. "Improvements in and relating to central battery telephone systems." P. Arnheim. April 19th.

8,443. "Improvements in connection with trolleys of electric tramcars and the like." H. Halstead, A. Johnson and S. Winn. April 20th.

8,444. "An improved 'cut-out' for electric lamps and holders and other purposes." A. Walker and J. M. Walker. April 20th.

8,481. "Luminous electric pen." A. G. Mountfort. April 20th.

8,511. "Improved method of and means for 'tuning' Hertzian wave receivers to particular transmitters." C. Hulsmeyer. April 20th. (Complete.)

8,540. "Improvements in induction meters." Compagnie Anonyme Continentale pour la Fabrication de Compteurs a Gaz et autres Appareils. (Date applied for under Patents Act, 1901, February 16th, 1905, being date of application in France.) April 20th. (Complete.)

8,541. "Improvements in the regulation of electric circuits subject to rapidly fluctuating loads." E. S. G. Rees, C. H. Iles and W. Armistead. April 20th.

8,563. "Improvements in electric arc lamps with multiple carbons." W. Gamble. April 20th.

8,567. "Improvements in and relating to systems of electric distribution employing mercury vapour lamps or the like." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 20th. (Complete.)

8,568. "Improvements in and relating to machines for use in the manufacture of incandescent electric lamps." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 20th.

8,569. "Improvements in and relating to dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 20th.

8,570. "Improvements in and relating to the regulation of the output of electric generators driven at varying speeds." The British Thomson-Houston Co., Ltd., F. Holden and A. S. Garfield. April 20th.

8,571. "Improvements relating to systems of electric transmission." J. D. Hilliard, jun. (Date applied for under Patents Act, 1901, April 20th, 1904, being date of application in United States.) April 20th. (Complete.)

8,613. "Apparatus for electrical drying of insulation of cables." G. H. Nisbett. April 22nd. (Complete.)

8,615. "Improvements in electric switches." W. F. Jones, D. G. Macmillan and G. J. Neybergh. (Date applied for under Patents Act, 1901, January 12th, 1905, being date of application in Belgium.) April 22nd. (Complete.)

8,652. "Improvements in plug boxes and the like for the connection of electric conductors to the main supply cables." G. A. Kirk and The Corlett Electrial Engineering Co., Ltd. April 22nd.

8,656. "Improvements in and relating to electro-mechanical block signalling systems for railways and the like." A. Beer. April 22nd. (Complete.)

8,659. "Means for protecting electric telegraph lines against the influencing action of alternating current lines situated in the neighbourhood thereof." Siemens Bros. & Co., Ltd. (Siemens-Schuckertwerke G.m.b.H. Germany.) April 22nd. (Complete.)

Car Life-Guards.—Messrs. Hudson & Bowring, Ltd., have received through the Brush Co. a further order for the fitting of the Yarmouth cars with the "H.B." life-guards, also the new cars for Plymouth and Scarborough. They have received orders from Messrs. Hurst, Nelson & Co. for the fitting of 12 cars for Mansfield, and 15 for Stalybridge, with the same type of guard.